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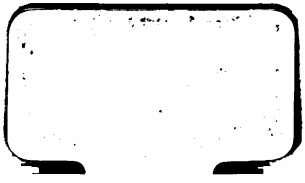

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Chatham 18th July
1833

My dear Sir Willoughby

I herewith inclose
a copy of a Book
Printed by me, but
not published, on the
Practical Operations
of a Siege, of which
I beg your acceptance

I am sorry I did
not send it sooner. If
you find reasons
from your official
Duties to look
into it, I hope you
will allow that
we have made.

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some improvements

Remain
my dear Sir W.

Yours very faithfully
C. Wheatley

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# RULES,

CHIEFLY DEDUCED FROM EXPERIMENT,

FOR CONDUCTING THE

# PRACTICAL OPERATIONS OF A SIEGE,

BY

C. W. PASLEY, LIEUT.-COL. R.E., F.R.S. &c.

## PART I.

CONTAINING THE PREPARATION OF THE NECESSARY MATERIALS, AND THE TRACING AND EXECUTION OF THE FIRST AND SECOND PARALLELS, AND OF THE APPROACHES CONNECTED WITH THEM.

PRINTED
FOR THE USE OF THE ESTABLISHMENT FOR FIELD INSTRUCTION
CHATHAM.

1829

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# PREFACE.

It is proposed, that this work, when finished, shall contain the substance of a number of Papers, lithographed at this Establishment for some years past, for the use of the junior Officers of his Majesty's and of the Honourable East India Company's Engineers, but which have not before been connected or combined. The Rules laid down, for conducting each Operation, are chiefly deduced from the practice of the Establishment, as implied in the title; and when no remark to the contrary is made, they may be relied upon with confidence, as the accurate result of repeated experiments.

A necessary regard for economy has however prevented us from carrying on some few of the operations treated of, on a sufficient scale, to enable us to lay down rules for conducting the same, with that degree of confidence, which in practical subjects, practice alone ought to confer. Great care will therefore be taken throughout every part of this work, to draw the line, in regard to such operations, that the reader may always be able fully to discriminate, between those which actually have, and those which have not been carried on, in ample detail, in the practice of this Establishment.

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In public Institutions established for the promotion of general science, there can scarcely be a doubt, as to the propriety of publishing every new result for the benefit of mankind. But in any national Military Institution, the expediency of such liberality is very problematical, inasmuch as those Institutions are always attended with more or less expense: and it seems unreasonable, that Foreign Powers who bear no share of such expense, should profit by any new information thereby obtained, especially, as in the event of war, they may use it to the injury of that nation, from which they derived it. Without therefore presuming to attach too much importance to the Practical Operations of the Establishment under my direction, I felt disinclined from the first, to publish any detailed account of them for general circulation; and when the subject happened some years ago to come under discussion, General Mann the Inspector General of Fortifications, expressed his desire to me, which I considered equivalent to an order, that the books or papers lithographed or printed for the use of this Establishment, and relating to the peculiar duties thereof, should not be published or used as materials for publication; excepting of course such parts of their contents, as are common to all elementary books on Fortification and the Attack of Places. Let it therefore be understood, as the condition, under which these works are issued, that the Officers or Gentlemen in public situations, who may obtain possession of them, shall stand pledged to exercise due discretion in this respect, and to abstain from using them for any other purpose, than the Military service of this country, for which exclusively they were printed.

In offering these opinions, it is not to be supposed that I am an advocate for mystery or illiberality. On the contrary, whilst I do not see the necessity for publishing all our Military or Naval Improvements for general circulation, and thereby affording the whole world the means of learning,

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without either trouble or expense, what may have cost us the labour of years, and large sums of money: I have invariably received Foreign Officers of all Nations, who have visited this Establishment, with that degree of cordiality, which I should wish to experience myself, under the like circumstances; and have afforded them as much general information, as they could reasonably desire. To British Officers, whether of the King's or Company's Service, and to young Gentlemen, intended for the Military profession, being British subjects, who have requested to attend the Practice of this Establishment, from time to time, the same facilities of improvements have been afforded, as to the Junior Officers of the Corps.

The second part of this work will contain an Essay on the Construction of Batteries in the Field. The third will comprehend the Regular Sap, and the Practice of Military Mining: the Fourth will treat of the final Operations of a Siege, such as the passage of wet ditches, &c. together with the use of hand Grenades, and the practice of Escalading; both of which may come into play, in a siege. Rules for construction of Military Bridges will probably form the subject of a separate Treatise, in a similar form.

As these works are not published for general sale, and consequently the number of copies will be limited, it may probably be necessary to put a higher price on them, than printed books of the same size and quality are usually sold for: but whatever profit, if any, may arise, after covering the expense of paper, printing, &c., will be applied to the benefit of the Establishment, according to the practice hitherto followed, in respect to the lithographed works on the same subjects.

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# PART I.

## SECTION I.

### OF PREPARING TIMBER AND BRUSHWOOD, FOR MILITARY PURPOSES.

#### 1. OF THE LARGE TIMBER REQUIRED IN A SIEGE, OR CAMPAIGN.

In the Siege of a Fortress situated on the Sea Coast, platforms, timbers for powder magazines, mine frames, &c., may be sent from England: but in inland operations, it is often or generally necessary, to cut materials for those purposes in some adjacent wood. In a campaign, abbatis, stockades, palisades, and chevaux de frize are often required to strengthen positions, and temporary powder magazines, and bridges are also necessary for field works. Bridges of trestles, or even floating bridges, as a substitute for pontoons, may likewise be necessary in the field. All these services require large timber, or young trees; the former to be cut into regular scantling, and planks, the latter either to be well squared, roughly squared, or left round, according to circumstances.

#### 2. OF THE TOOLS, &c. REQUIRED FOR CUTTING TIMBER FOR MILITARY PURPOSES.

Large trees may be cut by the felling axe, or by the cross-cut saw.

Young trees, not exceeding 6 or 8 inches, and not less than 2½ inches in diameter, should be cut by the topping axe.

In England, where timber is valuable, trees are cut by the cross cut saw close to the ground, after being previously scored, or opened, by a light felling axe.

In the field, and in countries where timber is of little value, large trees are always cut by the felling axe; a narrow strong wedge-shaped axe. It is more expeditious than the cross-cut saw, considering that two men must work together, in using the latter. It requires less skill to use it, and is less easily broken, or injured.

The topping axe is a thin light broad axe, used not only for cutting young trees, but for lopping off the branches of



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large ones, previously cut down by the felling axe, or cross-cut saw. From the latter service it derives its name. The topping axe will break, if used to cut large timber.

The cross-cut saw is necessary for cutting large trees transversely, after being felled: the hand saw is more convenient for small ones.

The pit saw is of indispensable necessity for preparing large trees into scantling and planks, fit for platforms, bridges, mine frames, sheeting, &c.: also for sawing them down the middle, if considered larger than necessary, for stockades or palisading. Dogs, iron implements for securing the trees whilst being sawed, and cant hooks, for turning over, or dragging them, are useful.

The carpenter's broad axe is the most useful tool for rough squaring. The adze may answer the same purpose, but it is more particularly adapted for cutting concave curves, when necessary.

Wherever saws are used, setters are necessary; one to each saw, if detached, one to several saws, when working together. One kind of setter is used for the pit and cross-cut saw. Another, of a smaller size, for the hand saw; and to every individual saw, files are required, in a proportion not less than a dozen to each, even for the shortest service.

Where cutting tools are used, a grindstone is necessary, to which a proportion of rub stones may be added. The latter may serve in lieu of a grindstone, but not so conveniently. Ragstones (or whetstones) are also necessary.

Recapitulation of tools for cutting and preparing large timber into scantling and planks.

| | |
|---|---|
| Felling axes. | Cross-cut saws. |
| Topping axes. | Files for ditto, dozens of. |
| Pit saws. | Setters for ditto. |
| Files for ditto, dozens of. | Hand saws. |
| Setters for ditto. | Files for ditto, dozens of. |
| Chalk lines, and Chalk. | Setters for ditto. |
| Plum Bobs. | Carpenters' broad axes. |
| Squares, iron, 2 feet (divided). | Adzes. |
| Compasses, 6 inch. | A grindstone. |
| Dogs. | Rubstones. |
| Cant hooks. | Ragstones, or whetstones. |

The best men for cutting trees are woodmen: next to these, who probably would be rare in a British Army, are carpenters and wheelers. The best men for forming them into scantling and planks, are sawyers, next to whom are carpenters or wheelers.

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Pickaxes and shovels are necessary for forming sawpits in the field. Ropes or chains would also be required for moving the trees. Handspikes, rollers, and wedges may be cut in the wood.

If you should wish to raise your timber on trestles in sawing it, in preference to making a pit, 2 inch socket chisels and mallets, with half inch spike bits, and spikes, will be required for making the trestles, in addition to the carpenter's tools before-mentioned.

### 3. OF THE SMALL TIMBER, OR BRUSH WOOD REQUIRED IN A SIEGE, OR CAMPAIGN,

A great number of fascines, gabions, and pickets are indispensable in a siege, and are often necessary in field works.

For this purpose, brushwood, not exceeding from 1½ to 2 inches in diameter at the butt end, is most suitable. The thicker pieces are usually called poles. The smaller ones are called rods.

Brushwood of oak, or other hard wood, usually requires from 8 to 10, or even 12 years' growth, according to the nature of the soil, before it is fit for fascines or gabions. The willow, cultivated for this purpose in the Ordnance plantations at Upnor, usually attains the proper size in one-half of the above time, and for that reason we prefer it for the use of this Establishment, as is makes more frequent returns; but on service, if both kinds lay equally convenient, I would recommend using the harder woods in preference to willow, as they are less liable to decay. When brushwood is not to be had, branches of trees may be used for the same purpose: and the pickets in particular may always be split out of large timber.

### 4. TOOLS &C. REQUIRED FOR CUTTING BRUSHWOOD.

For this purpose, no tool is so efficient as the bill-hook,* with which the great body of men employed on this duty ought to be supplied. A very small proportion (say one in ten) of topping axes, may be used for the larger poles, or young trees, when such are required. The hand-hatchet is comparatively useless.

* Formerly a two edged bill-hook was used in the Service, calculated to act both as a hand-hatchet and bill, or to chop as well as cut. Recently this complex and less efficient instrument has been abolished, and a bill hook of the Kentish pattern, a large curved knife, with the edge on the concave side has been adopted, in lieu of it. In making hurdles, woodmen sometimes use a block bill for chopping pickets, which has a straight edge, with a small hook at the back: but by a little management, the common bill will chop as well as cut, and it is not worth while to use two tools for military purposes.

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A grindstone or rubstones, and ragstones, or whetstones, are, of course, absolutely necessary.

In cutting brushwood, a pair of stout gloves is necessary to protect the hands against thorns. Leggings on the left leg, are also worn by regular woodmen, but, on Service, the latter may be dispensed with.

The regular woodman usually employs a boy with a bill-hook, to clear away the small brush, brambles, &c., after which he follows with his bill and topping axe, and cuts the rods and poles, of the description proper for fascines, gabions, and pickets, which are carefully assorted in several sizes, and are used for various purposes in civil life.

Recapitulation of tools, &c. for cutting brushwood.

| | |
|---|---|
| Bill-hooks. | Rubstones. |
| Topping axes. | Ragstones or whetstones. |
| A grindstone. | Gloves. |

### 5. RULES FOR CUTTING BRUSHWOOD.

The best way is to strike obliquely upwards, back handed, which, if the bill is sharp, will sever a small rod at a blow. If two blows are required, let the next be taken also upwards, in the contrary direction. When more than two are required, let the first slant upwards, and the second slant downwards, both on the same side: and let a third blow be taken upwards on the contrary side. In all cases it is desirable to give to the stub a slope, ridge, or point, to throw off rain water; and great care should be taken not to split it, which, by causing moisture to lodge on it, will rot it, and prevent a succession of brushwood from growing on the same ground.

In the plantations at Upnor, attached to this Establishment, no brushwood is to be cut excepting in winter: and only a small number of picked men are allowed to cut it, under the immediate superintendence of the Foreman of the Plantations and Grounds. These men are not changed, until the whole quantity required for the season is completed.

In preparing for a siege, so very large a quantity of brushwood must be cut, and consequently such a number of men must be employed, who probably never used a bill-hook before, that the preservation of the stub must of course be neglected.

### 6. DETAIL OF MEN FOR CUTTING BRUSHWOOD.

When troops are ordered for this duty it will be most convenient to tell them off in divisions of 25 men each. These

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must be subdivided into squads, in proportion to the number of Non-commissioned Officers present, each of whom will be responsible for the work of his own squad, but Corporals, as rank and file, are not exempted from their share of personal labour, unless it should be considered, that they may be more usefully employed in superintending. The men must be drawn up in single rank, and in extended order, not less than 3 yards apart: and if there be not room for the whole of the divisions employed, to work in one line, they may either commence in several parallel lines, at intervals of about 30 yards apart, or on different sides of the wood. The brushwood must be made up into bundles, loosely bound together by withes; the size and weight of each to be such, as a man can conveniently carry to the rear. In wood that has just attained the proper age, a bundle may contain from 20 to 25 rods. The average weight of those made by military working parties will scarcely exceed 40 lbs. On commencing the work all the men should cut: afterwards a few should be told off to bind and carry. The whole should be tasked to prepare so many well sized bundles per man.

### 7. MEAN PRODUCE OF AN ACRE OF BRUSHWOOD, &c.

The produce of brushwood, planted on any given extent of ground, varies according to the quality of the soil, and climate, as well as the nature and age of the trees planted.

In the first years of this Establishment, when a Progress Book was kept, containing records of every day's work, the produce of several woods in the neighbourhood of Luton, purchased, and cut by us, for the purpose of making fascines, and gabions, was registered. The brushwood consisted chiefly of oak, with a mixture of hazle, beech, and ash: and was of 8, 12, 14, and 15 years old, at the period of cutting. Fifty men repeatedly cut an acre as their day's work, which seems to have been cut in from 4½ to 6 hours of actual labour on the spot, not including the time of marching backwards and forwards. On other days it appears, that the same number of men only cut half an acre, but this last rate generally applied to the oldest portions of our brushwood. Indeed, it is evident, that the older and thicker the wood, the longer will it take to cut. The old bill hook then used was bad, and the men had never been accustomed to this kind of work before.

The produce of an acre varied from about 900 to 1200 bundles. 1000 may be assumed as the mean number, and 18 tons as the mean weight of the whole; and this quantity ap-

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pears, from the same records to have been capable of furnishing about 250 long fascines, and 1500 pickets, or about 1000 trench gabions.

In conveying the brushwood from the woods to Chatham Lines, waggons with 4 horses were employed, which carried from 52 to 70 bundles each, according to the age of the brushwood. The roads near the woods were exceedingly bad. Seven fathoms of 1½ inch rope were used to bind the load of each waggon.

The rule for estimating this kind of work, that will be given in the next article, and which has been deduced from the above data, must be considered as a mere approximation towards the probable quantities.

### 8. ESTIMATE OF MEN, TIME, AND MEANS OF TRANSPORT, NECESSARY FOR CUTTING AND CARRYING OFF A GIVEN QUANTITY OF BRUSHWOOD.

Any able bodied man may be expected, after some days' practice, to cut, bind, and carry to the rear, in one hour, 4 bundles of brushwood of the proper size for military purposes, and capable of being made up, either into 1 long fascine, and 6 pickets, or into 4 trench gabions, or hurdles.

Hence each division of 25 men, rank and file, may cut, bind, and arrange in 5 hours, about 500 bundles of brushwood capable of being made up, either into 125 long fascines and 750 pickets, 6 to each fascine, or into 500 trench gabions or hurdles; and the ground cleared may be roughly estimated at about half an acre, or if reckoned in yards, at about 2500 square yards,* or at the rate of 20 yards per man, per hour; that is, if the brushwood be rather thin.

If the men have to march about four miles to the wood, a task involving 5 hours labour on the spot, will probably be sufficient for each relief, or party of men. If the wood should be nearer to the camp, their task may be increased.

The above quantity of brushwood will make nearly 18 cart loads of 28 bundles each, to be drawn by 2 horses in bad roads; but as the rods will measure from 8 to 11 or 12 feet in length, the carts employed for this purpose must be fitted like hay carts, by letting down or taking off the back board, and fixing a frame over the shafts in front. The latter may be made of rough timber cut in the same wood, where the brushwood is obtained. Four fathoms of 1½ inch rope will be necessary to bind the load.

* Half an acre is only 2420 yards, but it was not worth while to go to any nicety in this part of the estimate, which must necessarily be extremely vague.

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# SECTION II.

## RULES FOR MAKING FASCINES.

### 1. OF FASCINES.

FASCINES are a superior kind of faggot, which being built in courses, with a moderate slope, and secured by pickets driven into an earthen parapet, form a revetment useful in Field Works.

*A Fascine*, when the term is used without further specification, implies one about 18 feet long, and 9 inches in diameter, such as is used in reveting batteries, &c.; and which can be cut to any shorter length, as may be required, during the execution of the Field Work, in which it is used. To make fascines thicker than the above dimension would be a waste of materials.

*Trench Fascinès*, 6 feet long, are used for crowning a line of gabions in a sap. These are formed by merely sawing the common long fascine, or *Battery Fascine*, into three parts.

In like manner, 9 feet fascines, which are useful for covering blinded galleries, and for other purposes, are formed by sawing the common long fascine into two equal parts.

### 2. DETAIL OF MEN.

The men employed in making fascines, must be divided into squads of 5 men each, besides which there must be spare men, in the proportion of one to every three or four squads, to prepare pickets. One private in each squad is appointed to direct, but not without taking his share of the labour. One non-commissioned officer has the charge of several squads.

### 3. TOOLS, &c. FOR EACH SQUAD.

5 Pairs of stakes, for trestles, or more, if the brushwood be bad.

5 Lashings, or withes for ditto.

| | |
|---|---|
| 1 Fascine choker. | 1 Fid of hard wood. |
| 1 Maul | 1 Six feet rod. |
| 1 Hand-saw. | 1 Gauge for the bands. |

3 Bill-hooks
2 Gabion knives } at the rate of 1 cutting tool per man.

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*For the spare men making pickets.*

1 Bill-hook } for each man.
1 Chopping block }

*For several squads.*

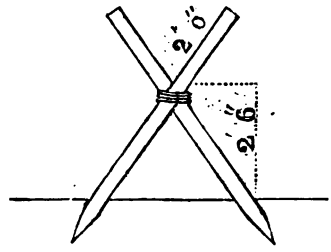
1 Grindstone, or several rubstones.
Ragstones, or whetstones.

REMARKS. The size of the common hand-saw is convenient, but its teeth are rather too large for cutting brushwood expeditiously. If regular 6 feet rods cannot be issued to each squad, let a rod, 8 feet long, cut out of the brushwood, be used as a measure for each squad that is deficient. Two lengths of this rod will mark the distance between the extreme trestles. The fids of hard wood should be about 9 inches long, 1 inch in diameter, and pointed at one end. The gauges are pieces of wood about 15½ inches long, also cut out of the brushwood. Chopping blocks it is needless to describe: but if large timber is not to be had, stout stakes driven into the ground, and standing about 2 feet above the surface, will answer the purpose. If a lower block be used, the man must work kneeling.

### 4. METHOD OF PREPARING FASCINE TRESTLES.

Fascines are made in a cradle, composed of a certain number of trestles placed at intervals, not exceeding 4 feet apart.

Each trestle consists of a couple of stakes, about 6½ feet long, and not less than from 2½ to 3 inches in diameter, driven obliquely into the ground, touching each other, and crossing at right angles, or nearly so, in the form of a St. Andrew's cross. The upper part of the cross should stand at the perpendicular height of about 2 feet 6 inches above the ground, with the ends of the stakes projecting obliquely, about 2 feet beyond it, as in the annexed figure.



At the center of the cross, the trestle may be secured by a lashing 6 feet long, consisting of a piece of spun yarn or of tarred line, of the size of tracing line, or a very little larger. This is done by applying the middle of the lashing to the two stakes, and passing the ends horizontally round both, in

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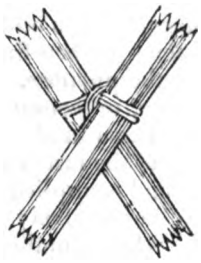
contrary directions, until three or four turns are taken. The ends are then crossed vertically round the center of those turns, in the space between the two stakes, and hauled taught; and after taking two or three turns in this new direction, as shewn in the annexed figure, the ends are tied together with a reef knot. The turns last taken are technically termed frapping turns, and by straining the first parts of the lashing, keep every thing tight. A withe or twisted rod, may answer the same purpose, when lashings cannot be procured.



When one trestle is thus fixed, another is always placed at the distance of 16 feet from it. The intermediate trestles, which may be 3 in number, when the brushwood is good, making 5 in all, are then placed at equal intervals of 4 feet apart, between these two. When the brushwood is bad, that interval will be too great, and therefore 6, or even 7 trestles, may be used instead of 5. The head of the squad directs the placing of the trestles, assisted by two men of his party, whilst the others collect brushwood. After the first trestle is properly fixed, he alines the others by the eye, looking along the upper side of each stake, on the same principle, as in profiling.

Remark. At this Establishment, we sometimes use stakes of hard wood, of regular scantling, about $2\frac{1}{4}$ by 3 inches square, shod at bottom and hooped at top with iron, like small piles. Although these make very good fascine trestles, one would scarcely recommend using them on Service.

### 5. FASCINE MAKING DESCRIBED.

When the trestles are fixed, straight rods and branches, not exceeding about $1\frac{3}{4}$ inch in diameter, are laid over them, with their ends projecting about 17 or 18 inches on each side, beyond the extreme trestles. The leaves must be stripped off entirely, as well as the refuse ends of the thin branches. When the branches grow out of the stem, with irregular or clumsy bendings, they should be first separated by the bill-hook, as all very crooked parts injure the fascine: but straight and flexible branches may be laid in, along with the stem, cutting them half through or not, as may appear necessary. The men piling the brushwood should endeavour to lay the stouter rods outside, and the smaller stuff near the heart of the bundle. When the cradle is nearly full of brushwood, it will be time to prove the diameter of the proposed fascine,

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in several places, which is done by the fascine choker: and more stuff is added, in those parts, which require it. The fascine is then finished, by binding it with withes, prepared for the purpose. This is done by four men, two of whom choke, or compress the brushwood near the spot, where the other two bind. The first band is applied near the extreme end of the fascine, about 6 inches from the first trestle. The second is applied about 15½ inches from the first, and others are successively added at the same central intervals, until the whole number of 13 bands are completed. The fascine is then removed from the trestle, and the rough ends sawed off. It is to be observed, that these ends should be laid as regular as possible, in piling the brushwood, and no more should be cut away, than is necessary, although the length of the finished fascine should, in this case, prove to exceed the standard of 18 feet. In regulating the central distance from band to band, the gauge rod is used as a measure. If the brushwood be very bad, or withes of the desirable strength cannot be obtained, the intervals may be diminished to 12 inches, which will increase the number of bands to 17, and, in this case, a 12 inch gauge must of course be used.

Strictly speaking, 4 men are sufficient for making a fascine, when all the materials are at hand, but the fifth may be usefully employed in preparing withes, which is the most difficult part of the work.

### 6, METHOD OF PREPARING AND USING THE WITHES.

For *Withes* (or *Gads* as they are also called) to bind fascines, very straight rods must be selected, which when afterwards cut to the proper length of about 5 feet, should not be less than about $\frac{3}{8}$ths of an inch in diameter, nor greater, if possible, than about $\frac{3}{4}$ths or $\frac{7}{8}$ths of an inch at the big end. In choosing them therefore, let no part be smaller than your little finger, or much thicker than your thumb. All the small branches must be lopped off, not close to, or cutting in upon the stem, but so as to leave a small stump projecting about $\frac{1}{8}$th of an inch above it: otherwise the rod will be liable to break at each knot.

In preparing them for use, you must put the thick end under your left foot, and twist the rod with your hands, from the top downwards, with your right hand towards the end of the rod, which you will move in the same manner nearly, as if working at a winch, so as to turn the rod in the direction, technically called "with the sun."* Great care, must be

* "With the sun," and "against the sun," are in reference to the apparent motion of the sun, as observed by a man standing in the northern hemisphere, and looking towards the south.

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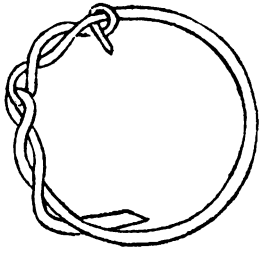
taken, to avoid making kinks in the wood, which unpractised persons are apt to do, as these spoil the withe.

After the rod is well twisted at the small end, and moderately so downwards, you will form a loop about 9 inches long, near the small end of it, by taking a half hitch with the end of the rod, round the body, or standing part of it, as in the annexed figure.

You will then give the loop a couple of twists in the contrary direction, so as to plait the double part of the rod, and form an eye, or smaller loop at the top of it, as in the second annexed figure. At the part where this eye is formed, the rod should not be less than half an inch in diameter.

Lastly, the end of the rod must be pointed, after which it will be ready for the use of the fascine makers. In this state it should be at least 4 feet long, which, after preparing one or two, a man may easily judge of by the eye.

In binding the fascine, two men assist, standing on opposite sides. They pass the withe under the brushwood, then bring the end together above it, and pass the big end of the rod through the eye. One man sets his foot upon the eye, and forces it home, it being at this time some inches lower than the top of the fascine. At the same time he hauls upon the end of the rod, turning it with his hands, until the part within the eye is more completely twisted, but, of course, in the same direction of the fibres as before. He then hands over the end of the rod thus twisted to his comrade, who bends it back, so as to form a new loop engaged within the former, like the two links of a chain, after which he (the second man) passes the end of the rod from left to right, under the standing part on his own side, over it again, and then under it a second time; whilst the first man assists with the fid, in disengaging the standing part, which, at this time is, of course, jammed close to the body of the fascine. After the second turn, the superfluous part of the rod is cut off; and then the two ends appear exactly alike, excepting that the thicker part has not got a half hitch at the extremity of it, like the other part.



The band when finished accor-

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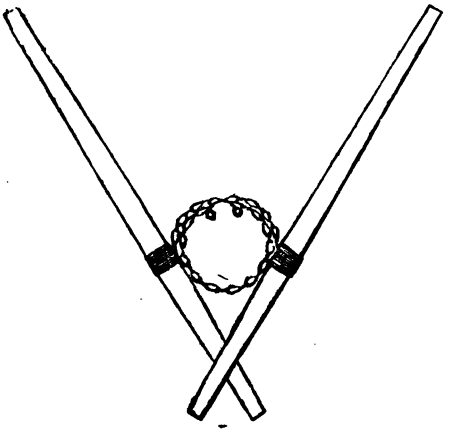
ding to this process, is represented in the foregoing figure, in which the fascine, supposed to be embraced by it, is omitted.

### 7. METHOD OF CHOKING A FASCINE.

The instrument called a fascine choker, consists of a stout chain, attached to a couple of ashen levers, each of which is 4 feet long, and cut out of $1\frac{3}{4}$ by 2 inch scantling, the section of the wood being an oval. The chain is four feet long, between the levers, which it embraces by means of a couple of iron sockets. It is fixed at the distance of 18 inches from one end of each lever, from whence it tapers to both ends. There are two small rings attached to the chain, one on each side of the center, at the distance of $28\frac{3}{4}$ inches apart, which corresponds with the circumference of a 9 inch fascine. In choking the bundle of brushwood, which is done by two men standing on contrary sides of it, the center of the chain is first brought under the brushwood, and then the ends of it, together with the levers, are brought over and crossed; the men handing over the opposite levers to each other, with the long ends uppermost.



The levers and chain will then appear as in the annexed figure, in which the chain is supposed to have made rather more than one complete turn round the fascine. The small rings are also represented, which do not yet meet, as the chain is supposed to be slack. The short ends of the levers press against the contrary sides of the fascine. Commencing at this position, the two men press down the long ends of their respective levers, and thus by degrees tighten the chain, until the brushwood is choked, or compressed into as small a space as possible, when it assumes the form of a perfect circle, or nearly so. At this period the long ends of the levers should be depressed below the horizontal line,* and

* Hence, if fascines were made of different thicknesses, the length of the chain of the fascine choker used, should vary according to the diameter of the proposed fascine. $5\frac{1}{2}$ times the diameter is a good proportion.

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the two rings, which at first were several inches apart, ought to meet at the top of the fascine.

As soon as each band is finished, the men employed in choking disengage their levers and chain, and commence at a new place. If any part of the fascine has been pinched in choking, it may be turned over when finished, and the bands or fascine beat with a picket, to render the latter quite cylindrical.

Remarks. In making fascines, the Officers and Non-commissioned Officers superintending, must be very strict, in regard to dimensions and neatness; more especially in seeing that the withes are properly selected, well twisted, particularly at the eyes, and in every respect made according to rule, for upon these, the strength of the fascine almost entirely depends.*

When good withes cannot be had, spunyarn may be used in lieu of them, which must be cut into lengths of 6 feet. In binding with spunyarn, the center of the piece of rope is laid upon the fascine, and the ends are passed under, so as to make one complete round turn; they are then hauled taught, by the two binders pulling against each other: after which they are brought together at top, and crossed so as to form the first part of a reef knot. The two men again haul taught, by pulling in contrary directions, after which one man presses down the joint of the spunyarn with his finger, until the other has taken the necessary turns, for completing the reef knot. Thus the band passes twice round the fascine, before the knot is tied.

If proper chokers are not to be had, a couple of stout stakes, and a rope doubled by splicing, or rather by tying the ends together, will answer the same purpose. The length of the rope must be equal to that of the chain and sockets, in lieu of which it serves. After the rope is passed round the fascine, and crossed, the ends of the levers are pushed through the bights of the rope, and the operation of choking is then performed in the usual manner.

* We tried experiments with green willow cut a month before it was used, to ascertain the strength of fascine bands of different kinds, by applying progressive weights, until the withes broke. Eyes formed according to rule, at a part of the rod not exceeding half an inch in diameter, required an average weight of more than 4 cwt. to break them; but in some few instances, the standing part broke before the eye. Under the supposition of such eyes being the weakest part, another method of forming a fascine band was suggested, in which the thick end of the rod was not passed through the eye, but round it, on the principal of what is called the midshipman's hitch in knotting with ropes; but on trial, the round turn thus taken with the thick end, unexpectedly proved to be the weakest part, and invariably broke under an average weight of 2 cwt. only.

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### 8. TIME REQUIRED FOR MAKING FASCINES, WEIGHT, &c.

Every squad of 5 men may finish fascines at the rate of one in an hour, after a few day's practice.* The average weight of an 18 feet fascine, is 1¼ cwt. or 140 lbs., after the wood has been cut some weeks.

### 9. OF FASCINE PICKETS.

The men employed in cutting pickets must provide them in the proportion of 6 or 7 to each fascine, and should make them up in bundles of 25. They should not be less than 3 feet 6 inches long, including the points, but 4 feet is better. A sharp triangular point is considered the best way of finishing the picket, and this form penetrates a stout fascine with great ease. The top should also be pointed, but very obtusely, as in the annexed figure; for if it be cut perpendicularly across, so as to form a plane surface, the picket will be liable to split, in driving. All the branches must be cut off quite close to the stem.

Fascine pickets should not exceed 1¾ inch in diameter at the thick end, but from 1¼ to 1½ inch is a better proportion. After a little practice, a man's eye is the best guide for judging of the proper thickness. When the stuff much exceeds two inches in diameter, pickets must be formed by splitting it into 2 or more parts, according to its size.

### 10. TIME REQUIRED FOR MAKING FASCINE PICKETS, WEIGHT, &c.

After a few day's practice, a man may cut and make up fascine pickets into bundles, at the rate of one bundle (or 25 pickets) in an hour. A couple of withes, or of pieces of spunyarn must be used for binding each bundle.

The average weight of a bundle of well-sized pickets, 3½ feet long, is about 30 lbs., after the wood has been some weeks cut.

### 11. OF TRACING FASCINES.

The tracing fascines, 5 or 6 feet long, recommended in all the Elementary Writers on the Attack of Fortresses, being of no use whatever, except to measure the task of each workman, in opening the trenches in a Siege; and it being evident,

* Expert men may make fascines much quicker when tasked, but it would not be prudent to calculate on making greater progress, with the common military working parties in a siege.

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that almost every other mode of effecting this measurement, that can be suggested, would be simpler than the above,* we have abolished the use of tracing fascines in the practice of this Establishment, and consider them obsolete. Before we came to this decision, we used to make them 4 inches in diameter, in order to waste as little brushwood as possible.

### 12. OF COVERING FASCINES,

Covering fascines are those made of stout picket stuff, not less than one inch thick, without any mixture of small brushwood. They may be used in place of planks for the superstructure of wooden bridges; and may also be used, if no stout planks or spars are to be had, for the roofs of Field Powder Magazines. They may be made of the usual diameter of 9 inches. Their length will depend upon the special purpose, for which they are intended. The withes should be particularly good.†

### 13. OF SAP FAGGOTS.

A sap faggot is a short but very strong fascine, about 3 feet long, and 9 inches in diameter, composed also of stout picket stuff; which may be used, instead of sand bags, for filling the interstices between the gabions, at the head of a sap. One picket usually projects 5 or six inches from the end of the sap faggot, and is driven into the ground to keep it steady, when set upright, in which position it is always placed. Sap faggots are also sometimes used for filling the gabions themselves, to hasten the progress of a sap, under peculiar circumstances.

### 14. OF TRACING PICKETS.

These are short pickets 18 inches long, and about 1 inch in diameter, which are useful in marking out the details of field works. When they are to be used in the dark, the bark should previously be stripped off.

* For example, if each workman must necessarily carry his own measure, would not a light coloured rod, either made of deal, or of brushwood, with the bark stripped off, be a much simpler and more portable measure, than a fascine of the same length?

† A covering fascine, made of willow, 12 feet long, and 9 inches diameter was found by experiment to be equal to the calculated strength of a piece of Riga Fir, about 2 inches, and 9-10ths square. Consequently covering fascines, although strong enough to bear the weight of any Military Carriage or Waggon, if supported by proper beams, not more than four feet apart, are not quite so strong as common 3 inch planks. The strength of a common fascine of the same diameter, was about 5-8ths of that of the covering fascine.

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They may be made rather more expeditiously than fascine pickets, and should be tied up in bundles of 25 each. Every bundle weighs about 8 lbs. when the wood is dry.

## SECTION III.

### RULES FOR MAKING GABIONS, AND HURDLES.

#### 1. OF GABIONS.

GABIONS are cylindrical hampers, open at top and bottom, which, being filled with earth, form a revetment useful in field works; but more especially in a siege, in the construction of batteries, and in the operations, called the regular and flying sap.

Light gabions are a species of basket work, and it requires greater skill and care to make them, than is necessary in making heavier ones, which may be compared to hurdle work.

#### 2. NATURE AND DIMENSIONS OF GABIONS.

Having tried a great number of experiments, in respect to the best size of gabions, we found that 1 foot 9 inches was the smallest, and 2 feet the greatest exterior diameter, that ought to be used; and that, in all cases, 2 feet 9 inches was the most convenient height.

A gabion is either designated by its exterior diameter, or by the purpose to which it is applied; but the former is the most accurate mode of describing it.

The 21 inch gabion is the most convenient for the regular sap, inasmuch as the trench of the first Sapper just fills it, so that it is better suited to that particular operation, than a larger gabion would be, and a smaller one would scarcely have stability enough. In reference to this property, the 21 inch gabion is often styled a *sap gabion.*

The 2 feet gabion is the most convenient for the flying sap, and for trench work generally; and indeed for every purpose but the regular sap. Hence it is sometimes styled a *trench gabion,* or a *battery gabion.*

To make larger gabions than the above would be useless; for we have ascertained, by repeated experiments, that 2 feet

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gabions form as strong and durable a revetment as those of greater diameter, which result is the more conclusive, as it was contrary to our expectations.

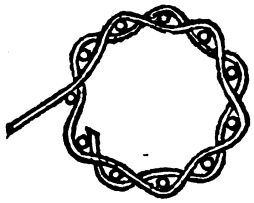
As the 2 feet gabion has more stability than any smaller gabion, and is better suited for the regular sap, than the 21 inch gabion is for general purposes; it has been agreed, that if only one of those kinds of gabions be used in a siege, the 2 feet gabion should have the preference, and for my own part, I recommend no other, unless in working upon very steep slopes; but, as opinions may vary, both sizes shall be treated of.

### 3. BASKET-WORK DESCRIBED.

Before we describe the method of making gabions, a few technical terms, and observations on basket-work, will be introduced.

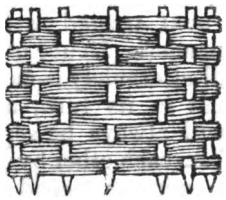
The upright parts are called the stakes or pickets. The wattling, or web, is composed of rods, the thick end of which is the butt, the small end is the tip. It is a rule that the rods shall always be a little smaller than the pickets.

In working with a single rod, which is called *randing*, an odd number of pickets must always be used. The rod is alternately passed round one picket, & within the next, and thus commencing at the bottom, it goes round in a kind of spiral, until the body of the basket or gabion is finished, as in the annexed figure, which represents the plan of the commencement of the work, the pickets being denoted by small circles.



Sometimes two or three rods are worked round together, precisely in the manner above described, and still using an odd number of pickets.

This is called *slueing*. The appearance of the work so finished is shown in elevation, in the annexed figure.





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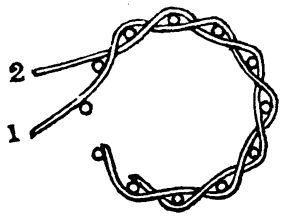
Neither randing nor slueing ought ever to be allowed in making gabions. They are both very weak, especially the latter; so that the strength of baskets made in this manner, depends entirely upon the top and bottom, which are always finished with greater care.

Working with two rods together, when braided or plaited, is called *pairing*.

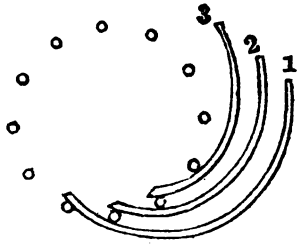
In this case, the two rods are separated by one picket. That, which is to the rear, is passed over the other rod, round one picket, and within the next. The second rod, which is now to the rear, is passed over the first rod, and also round one picket, and within the next.

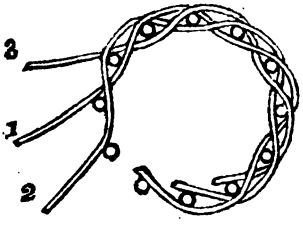
Thus the two rods cross each other alternately, over and under, as in the annexed figure. In this, and in all the succeeding methods, it is of no consequence whether the number of pickets be odd or even.




Working with more rods than two is called *waling*.

In waling with three rods, they are first placed with the butts inwards, and tips outwards, each being separated by one picket, as in the annexed figure. Then the first rod, which is to the rear, is passed over the other two rods, round two pickets and within one. The second rod, which will then be to the rear, is also passed over the other two rods, round two pickets and within one. The third rod is next treated in the same manner. Hence each rod will alternately come to the front in its turn, and they will always be separated from each other by one picket, as in the second annexed figure; and thus in winding spirally round the

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pickets, the rods will be braided into the form of a three stranded rope.

Basket makers sometimes wale also with four or five rods, in a manner, which I forbear to describe, as it is not applicable to military purposes.*

In passing a rod from the outside round the inside of any picket, and out again, the basket maker does not move it all round by the top, in the way that an inexperienced person would naturally do. Holding the rod in his left hand, with the tip pointing upwards, he passes the fore finger and thumb of his right hand, into the inside of the gabion, between those two pickets, through which the end is to come out, after making the required turn, and with these bent backwards, he grasps the middle of the rod, and pulls it out with a jerk, between the said pickets.

In circular waling, the rods should always pass round more pickets outside than inside.† In straight work, with the same number of rods this is not necessary.

When the rods for basket work, or for withes, are to be used any length of time after they have been cut, they must previously be steeped in water, to restore their flexibility.‡

The only basket maker's tool, applicable to gabion making, is the knife; which, for gabions, ought to be like a stout pruning knife. The *iron*, used by basket makers, for beating down their rods, may be superseded by a common picket, and the *cleaver*, a steel instrument for cleaving a rod into three parts, may be dispensed with altogether; for, in the process of gabion making, if any of the rods should be considered too large, it will be sufficient to split them into two parts, instead of three, which may be done by the bill-hook.

### 4. DETAIL OF MEN FOR GABION MAKING.

The men employed in making gabions may be divided into squads of three men each, of whom one prepares pickets, rods, and withes, whilst the others level the ground, and afterwards work at the gabion. In some cases, two men may suffice. One Private has charge of each Squad, under the Non-commissioned Officers, who superintend several.

* The best method for a young Officer to learn waling, is to provide some wires as pickets, which he may fix on a large pin cushion, and to use pieces of the small round cord called bobbin, as a substitute for the rods. In this way very neat models of gabions may be made.

† Because it is desirable that the inside of a gabion, or basket, shall be as nearly circular as possible. But if several pickets be passed inside by each rod, the interior outline will assume the form of a small polygon.

‡ It has also been recommended to heat green withes over a fire, before twisting them.



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### 5. TOOLS FOR EACH SQUAD.

1 Bill Hook.
3 Gabion knives (or 1 per man.)
1 Four feet Rod, or 3 sticks cut as guages, 1 for the height, and 1 for the diameter of the proposed gabion, and 1 for the length of the pickets.
1 Chopping block, or stake.
1 Piece of line, about three feet long.

The following tools are useful when heavy gabions are to be made, otherwise they may be dispensed with:

1 Handsaw.* 1 Mallet.

*Implements for several Squads.*

1 Grindstone, or several rubstones.

When a party of men are sent to make gabions, pickaxes and shovels, should be taken to the ground, if necessary.

When wooden bottoms are used in gabion making, the proportion is one per squad.

### 6. METHOD OF MAKING LIGHT GABIONS.

The pickets must be from 3 feet 4, to 3 feet 6 inches long; and their proper thickness is from $\frac{5}{8}$ths, to $\frac{7}{8}$ths of an inch.

The rods for the web should be from $\frac{5}{16}$ths or $\frac{3}{8}$ths, to $\frac{3}{4}$ths of an inch in diameter. Those for the withes should be a little thicker, and the most perfect that can be selected.

The number of pickets used in working with brushwood of the above description, should not be less than 12 for a 21 inch gabion; which number will also generally suffice for a 2 feet gabion, although you may increase it to 14, if you think proper.

Gabions are usually made by driving the pickets into the ground, and therefore in hard or rocky soil, small pits about $2\frac{1}{2}$ feet in diameter, and 9 inches deep, must be dug at proper intervals; and filled with loose earth, excluding stones and large gravel.

A circle of the proper diameter must then be traced, with a piece of string made fast to two short pickets; one fixed into the ground as a center, the other moving round to mark the circumference.

The diameter of the circle thus traced, should be one inch less than that of the proposed gabion. Hence the proper radius for a 21 inch gabion is 10 inches; that for a 2 feet gabion is $11\frac{1}{2}$ inches.

When this is done, the circumference must be divided into as many equal parts, as there are pickets to be used

* Even in making heavy gabions, the handsaw may be dispensed with, if the men are expert at the bill-hook.

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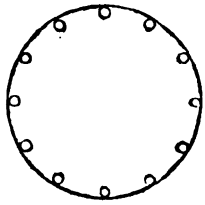
in the proposed gabion. When 12 pickets are to be used, the best way is to divide it first into 4 equal parts; and afterwards to sub-divide these portions into three each. A small piece of stick may be used as a measure.

All the pickets must next be driven, so as to touch the internal circumference, as shown in the annexed figure, and it is proper to place them alternately with the large and small ends upwards.



The rods prepared for the web must be entirely stripped of leaves and twigs; no part of any one single rod being used double, although in joining a new rod to the tip of one, that is coming to an end, these two may be laid together for a few inches.

The most approved method of forming the web of light gabions, is by waling with three rods, as described in the foregoing observations; but it will be best not to place all the butts, or thick ends, the same way.

If the stuff be larger than usual, pairing with two rods may be allowed, but this method must be confined to the body of the gabion only. Five or 6 inches of the bottom, and as much of the top, must always be waled with 3 rods.

Very thin short rods should not, in any case, be used at the top or bottom of a gabion: for, unless these portions of the work are finished with more than usual care, they are liable to separate from the remainder of the web, whilst the gabions are carried or thrown about. These portions may be formed of twisted withes, instead of common rods.*

In making the gabion, the web must continually be pressed down with the foot or hand, or beat with a stout picket; and the greatest care must be taken, to preserve the proper diameter, for which purpose a couple of rods may be cut as gauges, which may be placed transversely across the finished part and inside of it, pressing against two opposite pairs of pickets.

* Twisted withes, braided or plaited, are used in preference to common rods, for all very open wicker work, as they are less liable to separate from, or slip up and down the pickets, with which they are connected. In gabions this is not absolutely necessary.

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### 7. METHOD OF FINISHING GABIONS.

When the web is completed to the proper height of 2 feet 9 inches, it must be bound from top to bottom, with withes, previously well twisted, in four distinct places, and these should be applied, so as to secure the ends of the extreme rods, in preference to the middle of them.

The center of the withe being laid over the top of the web, the ends are passed through it, in contrary directions, a few inches from the top; near to each other, but not between the same two rods. Two men haul upon them, till they are quite taught. They then pass them again through the web, a few inches lower down, in contrary directions, and haul taught a second time; and thus they proceed by double stitches, as they may be called, like those of shoemakers, until the ends of the withe arrive at the middle of the web. The gabion being thus secured by four withes from the top downwards, disposed at equal distances apart, it is pulled out of the ground, and turned upside down; and an equal number of withes is used, to bind the remaining part of the web, in the same manner, so that the two sets of withes used shall meet, or cross each other, about the center of the gabion. The ends must be neatly secured, but in what manner is of little consequence. The stitches of these bands should be rather close, but not so as to embrace fewer than two spirals, of the original waling of the web.

Before the gabion is pulled out of the ground, the tops of all the pickets must be cut off about an inch above the web. This is usually done by a handsaw, but the expert woodman cuts off the heads of pickets by his bill hook, introducing a stout stake between two of the pickets, which he uses as a moveable chopping block, in striking at one of the two.

After the gabion is turned upside down, the points which originally stood in the ground may also be cut off, according to the same rule, if judged necessary: but at this Establishment, we always leave them, which appears to be rather an advantage than otherwise.

### 8. METHOD OF MAKING GABIONS OF VERY SMALL BRUSHWOOD.

Lighter gabions than those described in the preceding article are not to be recommended, otherwise than as a matter of necessity on service; or of economy, as at this Establishment, where very small brushwood is often used, in order that nothing may be wasted.

For example, when none of the brushwood runs larger than about $\frac{5}{8}$ths or $\frac{3}{4}$ths of an inch, the pickets will not of course

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exceed from ½ to ¾ of an inch, and the rods may vary from ¼ of an inch, or even less, to about ½, or, at the utmost, ⅝ths of an inch.

In this case, the number of pickets used must be increased from 12 to 16, or even 20, using the greatest number to the smallest brushwood; and the making of gabions with such very light materials, requires more than usual dexterity and attention. In other respects the method is the same, as in making the common gabion before described.

In gabions made of very small brushwood, the ends of the pickets should always be cut off, after drawing them out of the ground, otherwise they are liable to break. This is done by the gabion knife, not by the saw or bill hook.

After finishing one gabion, and drawing it out of the ground, the same picket holes will answer for commencing a second gabion, without describing a new circle.

### 9. OF WOODEN BOTTOMS FOR GABION MAKING.

In making gabions, wooden bottoms have sometimes been used, consisting of planks ledged together on the lower side, so as to form a circle like the head of a cask with holes cut all round, near the circumference, to drive the pickets into. I am informed that this facilitates the operation, and saves time, when inexperienced men are employed; but I conceive that no extra implements of this description, that can possibly be dispensed with, ought to be used on service.

### 10. METHOD OF MAKING GABIONS OF THICK BRUSHWOOD.

Sometimes thicker brushwood than usual must be employed for making gabions, as a matter of necessity. Sometimes stronger gabions may be desired for some special purpose, such as the interior revetment of a Battery, or of a Field Powder Magazine, in which case the thickest parts of the brushwood are selected.

The pickets for strong 2 feet gabions, need not exceed from ⅞ths to one inch, or, at the utmost, 1¼ inch in extreme thickness. The rods for the web should not be less than ½ or ⅝ths of an inch, and need not exceed 1 inch in thickness, the best being selected for the withes.

On account of the greater strength of the brushwood used, the pickets may be reduced to 8 or 10 for gabions of the above diameter:* and the whole of the web may be formed by pairing with two rods only. In other respects, the same method is followed, as in working with smaller brushwood.

* The proper number of pickets, for gabions made of strong brushwood, is in the proportion of 1 picket to every 2½ or 3 inches of diameter.

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### 11. TIME REQUIRED, WEIGHT, &c.

The time required for making gabions, by common military working parties, after some days previous practice, may safely be estimated as follows, observing that it increases in direct proportion to the number of pickets, and smallness of the rods used.

TIME. Three men will finish a 2 feet gabion, with only 8 pickets and of large brushwood, in 2 hours: they will finish a common gabion of 12 pickets, and of smaller brushwood, in 3 hours; but they cannot finish properly a very light gabion, of from 16 to 20 pickets, and of the smallest brushwood, that can be used, in less than from 4 to 5 hours.

WEIGHT. The average weight of 21 inch gabions, seldom exceeds 28 lbs. when the wood is dry, and even the lightest are not much beneath that standard.

The average weight of 2 feet gabions may be estimated at 36 lbs. and they scarcely ever much exceed 40 lbs. even when made of large brushwood.

### 12. OF SAP ROLLERS.

Finding, by experiment, that a stuffed gabion, 6 feet long, and 4 feet in diameter, if filled with small brushwood, was not musket proof; but that, if filled with pickets, it was perfectly unmanageable; the sap roller was adopted by us in preference.*

The sap roller is a hollow cylinder, formed by making 2 concentric gabions, each 6 feet long, one of 4 feet in diameter, but the other about 2 feet 6 inches in diameter only, so as to leave a clear interval of nearly 8 inches all round, between these two, which is afterwards stuffed with 6 feet fascines, and with rods not less than about 1 inch in thickness. The larger gabion of these two should have more than the usual number of withe-bands, in proportion to its diameter.

As we found it difficult to procure pickets of brushwood long enough, and at the same time perfectly straight for our sap rollers we have often used pickets split out of deal, and about 1 by 1½ inch square. For the larger gabion of the sap roller, we generally used 20 such pickets, and for the smaller gabion 14.

Sap rollers serve as a substitute for mantlets. In the single sap, one sap roller is used. In the double sap, two sap rollers, of the ordinary size, are used, with one of a smaller size. The latter may be only 3½ feet long, and rather less than 4 feet in diameter.

To prevent the sap rollers from losing their shape, at one

* At the suggestion of Captain J. M. F. Smith.

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time we introduced internal wheels made of plank; but recently we have adopted the simpler expedient of driving 3 pairs of strong pickets, not less than about 1¼ inch thick, through the large sap roller, and 2 pairs of such pickets through the small one; arranging every two pickets at right angles to each other, and cutting off the ends flush with the external surface of the roller.

### 13. TIME, WEIGHT, &c.

To make the inner gabion of a large sap roller, requires about 6 hours, and to make the outer one, 9 hours; to which must be added about two hours for stuffing, and combining them into a finished roller.

The average weight of the large sap rollers, now used by us at this Establishment, and stuffed with fascines and pickets, is 6¼ cwt. When the wood was green they must have weighed more: and it must be evident, that if they were of any other form than round, such a weight would be perfectly unmanageable.

The small, or rather the short sap roller, before described, may be finished in about two thirds of the above time, and weighs nearly two thirds of the former; their respective lengths being nearly as two to three, and all other particulars the same.

### 14. OF HURDLES.

Hurdles consist of strong wicker-work, of a rectangular form, and as they may occasionally be useful in a siege, the mode of making them shall be described.

The best size for military purposes is 6 feet long, and 2 feet 9 inches high. The same kind of pickets will therefore answer, as in making very strong gabions; and, generally speaking, the rods for hurdles should not be much less than an inch in diameter. An even number of pickets must always be used: and I consider ten a good proportion for a 6 feet hurdle, although the woodmen, in this neighbourhood, generally employ only eight for a hurdle of that length.*

In preparing to make a hurdle, it is necessary to describe an arc of a circle on the ground, with a radius of about 8 feet, making the length of the arc 6 feet. This space must be divided into nine equal parts. A picket is then driven into the ground at each end of it, and others into every intermediate point of division, making 10 in all. Then the wattling is begun, on the same principle nearly as in gabion making, excepting that you do not work round a circle, but

* The hurdles made by the Kentish Woodmen are either 8 feet long, with 10 pickets, or 6 feet long, with 8 pickets; and are usually 3 feet high.

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in a continued line: and therefore when you come to one of the extreme pickets at either end, you must twist part of your rod like a withe, and bend it round the picket; after which you must work in the contrary direction.

The woodmen assert, that hurdles intended to be straight, must always be made curved, in the first instance, as above directed, in order to prevent them from being crooked, when pulled out of the ground, which they say that those made in a straight line invariably become. And in hurdle making, they use a wooden sleeper, moderately curved, with holes for the pickets on its upper surface, which they lay flush with the level of the ground: but it would not be worth while to make use of such sleepers in the field. The annexed figure is the plan of a hurdle commenced in a curve, according to the above rule.

In commencing a hurdle, the men work from the bottom upwards, as in gabion making, but the first rod is not pressed down close to the ground, excepting in the center. Both its ends are raised about 9 inches above the ground, and there bent round the extreme pickets by twisting. Thus the first rods used form an arc of a circle, concave on the upper side. The second and third rods are bent round the extreme pickets, as close to the ground as possible, at each end of the hurdle, but in the center they rise higher than the first rods used: and thus the first three or four rods, or rather courses of rods, composing the web of the hurdle, are interlaced in such a manner, by crossing each other towards the center, as to prevent the separation of that part of the web from the pickets.

The ends of the rods are kept in their places by pressing against a picket, which jams them, and they are cut off about an inch in rear of it. It is not good workmanship to commence or finish with a rod, by cutting it off in this manner, close to either of the extreme pickets, as the twisted joint formed by bending the middle of a rod round those pickets, evidently gives greater firmness to the work.

After having been commenced as described, the remainder of the web is worked up in parallel horizontal courses, until it reaches the top of the pickets; and at this part one or two of the uppermost rods, after being twisted round the

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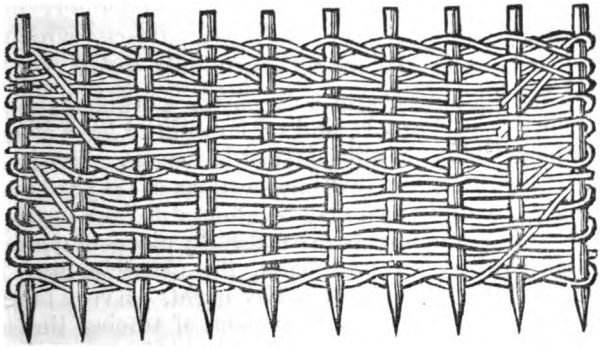
extreme pickets, are passed diagonally downwards in an oblique direction, towards the center of the hurdle, passing through and between one or two of the pickets. This arrangement, which is also sometimes done about half way up, as well as at the top, prevents the upper part of the web from separating from the pickets. The annexed figure represents a hurdle in elevation, just finished.



In making hurdles for civil purposes, it is usual to work by randing, or with single rods only, for the thick brushwood generally used in this process is so stiff, that it requires an effort to separate it from the pickets. But as military hurdles would be exposed to greater strains, than those used in husbandry, it is better to pair the rods in making them, which may either be done throughout the whole of the web, from the bottom upwards, or at least for several courses at the bottom, middle, and top; for this undoubtedly gives greater firmness to the work. But the precautions before described for interlacing the lowest, and finishing the uppermost courses of the web, render it unnecessary to use vertical withes for binding it, as in gabion making.

15. NUMBER OF MEN, TOOLS, TIME, AND WEIGHT.

The men and tools to be nearly the same as for gabion making, but with more bill-hooks than knives, and with a line ten feet long.

The probable time for making a 6 feet hurdle would be about 3 hours, I do not speak with certainty having made very few: and it weighs about 50 lbs. when the wood is dry.

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## SECTION IV.

### RULES FOR TRACING AND COMMENCING THE FIRST PARALLEL, AND THE APPROACHES CONNECTED WITH IT.

#### 1. METHOD OF TRACING THE WORK.

In opening the trenches in a siege, the workmen should be drawn up in single rank, and each ought to have a task assigned him, which should be 6 feet in length. Hence if the line marked out be divided into portions of 50 yards each, a working party of 25 men may be allotted to each portion.

The trenches in a siege are traced by pieces of white tape, previously rolled up into balls, the above colour being chosen, as the most conspicuous by night. Every tape is 50 yards in length, and has a short piece of tracing line added at each end, for the purpose of making it fast to pickets, or otherwise.

When the proposed trenches are extensive, they may be traced in several portions, and by several Engineer Officers.

When two Officers are employed in tracing a parallel, they may commence from the same central point, and work outwards. The mode of proceeding is as follows. Each Officer will draw up the Sappers, who are to assist him, in single rank, and will number them from right to left. Every man is to be prepared with a ball of tape, and a white picket. One or two supernumerary men may act as Orderlies: a Serjeant will assist.

In tracing part of a parallel, the Officer followed by his party marching in file, will advance upon a point therein previously fixed, where he will order the leading man to halt, and will take his tape from him, and march on with it, in the alinement of the proposed parallel, previously turning to the right or left, as may be necessary. The other men will follow the Officer. As soon as this tape is expended, the second tape-bearer will halt at the end of it, and deliver over the end of his own tape to the Officer, who will march on with it as before, in continuation of the proposed parallel. When this is expended, the third tape-bearer will halt, and will deliver the end of his own tape to the Officer, who will proceed in the same manner, until all the tapes are expended.

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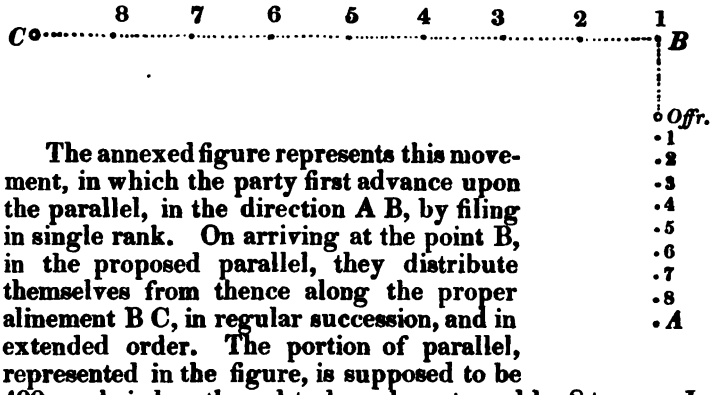


The annexed figure represents this movement, in which the party first advance upon the parallel, in the direction A B, by filing in single rank. On arriving at the point B, in the proposed parallel, they distribute themselves from thence along the proper alinement B C, in regular succession, and in extended order. The portion of parallel, represented in the figure, is supposed to be 400 yards in length, and to have been traced by 8 tapes. In this operation every tape-bearer, after halting and delivering the end of his tape to the Officer, drops the ball on the ground, and lets the tape slip through his fingers. Both parties must keep the tape near to the ground in windy weather; and take care that it be not pulled entirely away from the tape-bearer, when nearly expended. The ends of adjoining tapes must be tied together. The tape-bearers, who are now to act as markers, will place themselves on that side of the white line, which is nearest to the Fortress, and will face towards the point, from which the tracing commenced, as soon as they have taken post opposite to their respective marks; and if the ground be soft enough, they will fix their pickets into it, without knocking, and make fast the ends of the small line to the pickets. They are not to move on any account, before the working parties are properly distributed along the whole line.

### 2. METHOD OF ARRANGING THE WORKING PARTY, AND COMMENCING THE PARALLEL.

Whilst one Engineer Officer is tracing, another must direct the working party, who will assemble at the Engineer's Depôt, at least one hour and a half before sun-set, in close column of divisions of 25 men, drawn up two deep.

If the extension is to be made to the left of the first point, marked in the proposed parallel, the column must be drawn up right in front, but if the extension is to take place to the right of that point, the column must be drawn up left in front. Each division should be commanded by a Captain or Lieutenant, assisted by a due proportion of Officers and Non-commissioned Officers; and every Battalion furnishing the

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Working Parties should also send superior Officers in proportion, one to command the whole, others to superintend several divisions.

When the column is arranged as above directed, the men must be made to form single rank, which is done by causing them to open from the pivot flank, by the side step, until there is room for every rear rank man to come up successively into line, on the reverse side of his own front rank man. In so doing, every front rank man is to halt himself in proper time, that is to say, as soon as the rear rank man of the next file on his pivot flank comes up into line.*

After being formed in single rank, a Non-commissioned Officer or Private of Sappers will be placed on the reverse flank of every division, who is afterwards to assist in extending it, and in marking out the work; and who, for this purpose must be provided with a white measuring rod; and every man of the working party will now take up, or receive a shovel, which he is to carry in his right hand, and a pick-axe, which he must carry in his left hand.

To expedite this arrangement, a fatigue party should previously lay out the tools, in such order as to suit the column; the several sets of tools being placed in successive lines of 25 pairs each, at the distance of about 4 feet apart, so as to allow room for the men of each division, when in single rank, to form in rear of their respective tools, for the purpose of taking them up.

The divisions of the working party, formed as above directed, must be regularly numbered, and when all the men are provided with tools, each division must successively be marched off by files from its own right, if the column was formed right in front, or from its own left, if the formation was left in front.

Whilst this movement is in progress, the remaining divisions are to wait, until each preceding division has moved on in the aforesaid order. As every division is successively faced to the right or left, and put in motion, the Sapper on the reverse flank of it will lead. The Engineer Officer must be at the head of the first division, to guide the working party to that point, in the parallel, where the first marker is stationed, and from which the proposed extension is to begin. On reaching this point, the whole of the working party must be made to form line to the left or right, in extended order, in rear of the white tape, each man's place being regulated by

* When the column is drawn up right in front, the words of command for the above formation are, *From the left flank, form single rank—Right close—Quick march*: and *vice versa*, if the column should be left in front.

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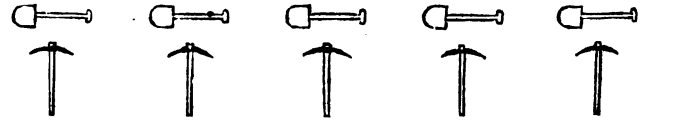
the Non-Commissioned Officer or Private of Sappers, who marched with the division. In so doing, the Sapper, who must be in front of the white tape, that is to say, on that side of it, which is nearest to the Fortress, must lay his rod down close to the tape. The first man of the working Party will then ground his shovel parallel to the rod, and also close to the tape, but in rear of it, placing the center of the shovel opposite to the center of the rod. The Sapper will then measure a second distance with his rod, and the next man of the working party will in like manner ground his shovel in rear of his rod as before directed. The Sapper will then measure a third distance with his rod, and thus he will proceed, until he shall have measured out the tasks of all the 25 men, of whom his division was composed; who during this time will form up into their proper places behind the white tape, in regular succession, each man marking the center of his own task by his shovel, when it comes to his turn.

The Engineer Officer superintending is to watch over the whole of this measurement and extension, with the greatest care, in order to prevent confusion. He must not allow any man of the working party to take post behind the white tape, until the Sapper is ready for him; and he must also see, that the latter does not move his rod, until each successive workman is properly posted.

In measuring the men's tasks, the white rod must be repeatedly turned over upon its ends, and therefore it should be a little shorter than the regular dimension fixed upon, because it gains a space equal to its own thickness, every time it is turned. Thus if the rod should be one inch square, and if the task of each man be supposed to be 6 feet, the length of the rod for marking it should only be 5 feet 11 inches.

As soon as each workman has grounded his shovel in the manner before directed, he must lay his pickaxe in rear of it, and opposite to the center of it, with the iron to the front. He will then sit or lie down behind his own tools, so as to be in readiness for work, and waiting the order to begin, in perfect silence.



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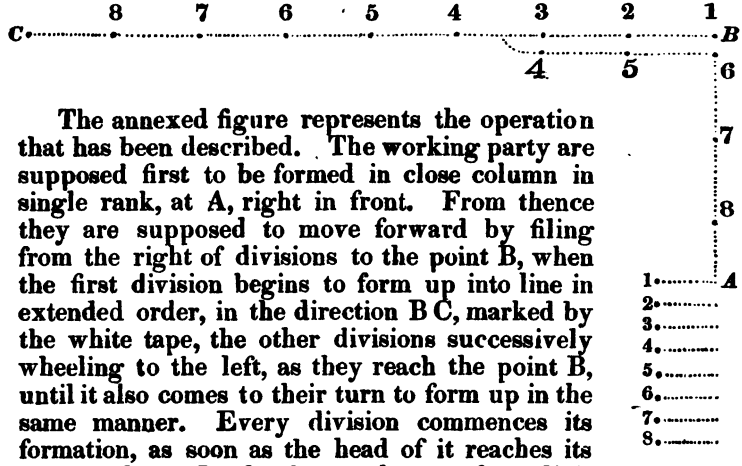
The foregoing figure shows the manner, in which the tools are arranged in rear of the white tape, which is represented by a dotted line. The large dots show the successive positions of the ends of the measuring rod, used by the Sapper.

As soon as the last division is extended on the reverse flank of the whole line, the men belonging to it, will be ordered to commence work, and this movement must immediately be taken up by the other divisions, with all possible dispatch; the Commander of each, as well as the Sappers attached to it, being on the alert, to watch the movements of the adjoining ones; and every Commander ordering his own men to rise, as soon as he observes the men of the next party on his reverse flank in motion.




The annexed figure represents the operation that has been described. The working party are supposed first to be formed in close column in single rank, at A, right in front. From thence they are supposed to move forward by filing from the right of divisions to the point B, when the first division begins to form up into line in extended order, in the direction B C, marked by the white tape, the other divisions successively wheeling to the left, as they reach the point B, until it also comes to their turn to form up in the same manner. Every division commences its formation, as soon as the head of it reaches its own marker. In the figure, the two first divisions are supposed to be properly formed: the third is represented in the act of forming. The remaining divisions are coming up by files, in single rank.

If the working parties understand what they have to do, the above extension may be executed with precision and without hurry, at the rate of one division in 1¼ minute, or of 100 men in 5 minutes. Thus it will not require more than 20 minutes to extend 400 men. It is not desirable that a greater number should be extended from the same point, in the same direction; but in extending from a central point, two distinct working parties may be made to file up together, under two different Engineer Officers, and in this case, the

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total number employed may be greater, and they will of course advance in double files, until they reach the point, from whence the extension is to take place.

It is to be remarked, that the extension of the working parties, after the tape is once laid down, is comparatively easy, but that the proper tracing of an extensive parallel, the first night that ground is to be broken before a Fortress, may be attended with very great difficulty, and therefore the Officers, who are ordered for this duty, cannot take too many precautions to avoid error.

When the working party begins to break ground, each man will seize his pickaxe, and cut a hole in rear of, and exactly opposite to the center of his own shovel, which he will then take up, and throw the loosened earth over the white tape, until the whole shall form a continued trench, of the dimensions prescribed for the first night's task, in a siege, which is usually 3 feet deep, and in that case should be at least 5 feet wide, measuring from front to rear. The original pickets, driven in to mark the task of every Division, should be carefully preserved; and the Officer of Infantry commanding it, should be held responsible for finishing his trench, according to the prescribed dimensions, throughout the whole extent of the 50 yards, thus marked out. The Field Officer commanding the working party furnished by each Battalion, should inforce the proper execution of the work laid out for the whole of the divisions under his command, he himself being held responsible for the same, by the General Officer on duty in the trenches. The Engineers superintending, and the Sappers attached to divisions, will only be responsible for tracing, and directing the work, and for measuring it, when reported to be finished, according to order; but not for the diligence of the men, which must entirely depend upon their own good will, and the zeal and attention of their Regimental Officers. The Sappers will assist in working, when they are not more usefully employed.

### 3. METHOD OF TRACING THE FIRST APPROACHES, OR THOSE CONNECTED WITH THE FIRST PARALLEL.

In tracing Approaches, the same principle must he acted upon. One Engineer Officer must be employed to lay down the white tape, and to arrange the markers.

When any of the angular points of the zig-zags does not coincide with the end of a tape, a spare marker must be placed there with three pickets, one of which he will plant at the angle; and in order to prevent the tape from



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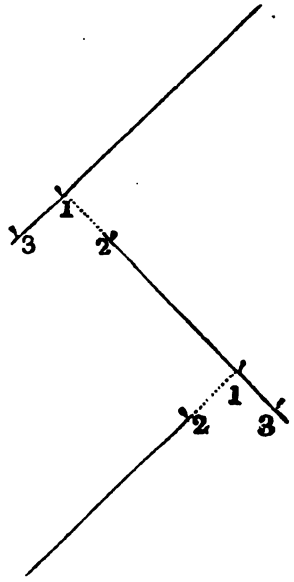
moving, it must be passed round this picket, or made fast to it; after which he will cut off about five yards of the tape, from the head of the branch immediately in rear of the angle, and extend it in continuation of the adjoining branch in front of it, produced towards the rear. The remaining pickets must serve to mark the extremities of the ends of the tape, after the angular part has thus been cut.*

This arrangement, which is represented in the annexed figure, serves to mark the returns, which are necessary at all the angles of the zig-zags. The dotted lines show the first positions of the small portions of the tape, that are afterwards cut off and moved in the manner that has been described. The figures 1,1, represent the positions of the original pickets, which mark the angles. 2 and 3 are the pickets afterwards driven to mark the extremities of the branches, after the returns (1, 3), (1, 3), shall have been traced.




### 4. METHOD OF ARRANGING THE WORKING PARTY, AND COMMENCING THE FIRST APPROACHES.

Another Engineer Officer will guide the men of the working party, who will advance by files in single rank, as before directed, until the head of the leading division reaches the tail of the proposed approaches, on the reverse side of the white tape, that is on the side farthest from the Fortress. The men will then be made to form up in extended order, along the white tape, a Non-commissioned Officer or Private of Sappers measuring the men's tasks, and placing them as before directed.

As soon as they reach the end of the first branch, which is marked by the point (2) in the foregoing figure, the Engineer who superintends this measurement, will lead the next man to the extremity (3) of the return of the branch immediately in front of it: and will cause him and the men who follow, to extend along the reverse side of the white tape,

* In our practice at this Establishment, the tapes are not to be cut, as on Service.

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which marks the second branch of the approaches, in the same manner as before directed, but with this difference, that if in extending along the first branch, they formed up to their right, they must now necessarily form up to their left, and *vice versa*; and at each succeeding angle of the zig-zags, the formation must be reversed in the same manner.

### 5. GENERAL REMARKS ON THE ABOVE OPERATIONS.

It appears essential towards the proper tracing of a first Parallel, that the front of attack of the Fortress to be besieged shall be well reconnoitred beforehand, and the distances of certain points, from the most advanced works, accurately ascertained, by day; from which fixed points the Engineers, who are to trace a parallel, should measure forwards towards the place, until they reach the exact position of the intended parallel, by means of a chain or tape, being the most accurate method, and as expeditious as any other; unless they have confidence in their own power of pacing. If it be possible to obtain a correct plan of the place, it will of course be of the greatest service, as Fortresses are usually surrounded by objects, such as roads, intersecting each other, buildings, &c., which cannot be destroyed in such a manner, but that traces marking their original position must remain.* Whatever be the reputation of these plans, they should however be verified by actual observation, instead of trusting to them implicitly. If correct, the fixed objects before alluded to furnish the most satisfactory data, for determining on the ground, the proper position of the first parallel, and of the approaches connected with it.

It appears of the most essential importance, that the tracing shall be executed before it is dark. Therefore unless the night chosen for opening the trenches is foreseen to be a moonlight night, it is absolutely necessary to commence early, and to have the tracing finished, before the end of twilight. If there should be no moon, and a foggy or cloudy night, this operation may be attended with the greatest difficulty and confusion, as we have found by experience at this Establishment. The arrangement of the men, on the contrary, as was before observed, is by no means difficult, after once the white line is marked on the ground; that is to say, provided that they themselves are well inclined, and attentive to the directions of the Engineers.

Having recently tried dark lanterns to mark fixed points in a parallel, for the guidance of the Officers and men em-

* At the siege of Copenhagen we obtained a Danish plan of extreme accuracy.



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ployed in tracing; the general opinion is, that, if used at all, a small part only of the blind of each lantern should be opened, so as to show a very feeble light, to the rear only, and without illuminating the ground, but in no other direction: for in attempting to show lights also laterally, they were invariably discovered from the Fortress. Moreover, dark lanterns, if employed at all, should only be confided to very intelligent and trust-worthy men; with proper directions how to use them, and orders not to part with them, until the tracing shall be finished, and the working party arranged, after which they should put them out.

As soon as the trench and parapet are well defined, which will take place in about an hour after the work has been commenced, the Sappers should carefully roll up and take care of the several tapes used in the tracing; but the pickets for marking out the work on the ground should not be removed, and it would be useful for those Sappers to provide themselves before hand, with white banderols, or with bundles of straw or other light coloured objects to be used as such, which should be planted on the reverse of the trench, opposite to the original boundary pickets, for the purpose of preserving the task of each party perfectly distinct in the dark: and such marks would be very useful even after daybreak.

### 6. RULES FOR ARRANGING THE SECOND AND THIRD RELIEFS OF WORKMEN, FOR A FIRST PARALLEL, AND THE APPROACHES CONNECTED WITH IT.

The Engineer will give directions, that after every party of 25 men shall have finished their task, each individual shall lay down his own shovel and pickaxe, close together, in rear of the spot where he worked, on the reverse of the trench, and near to the brink of it. Thus the tools being arranged by pairs, at intervals of 6 feet apart, or nearly so, will save the trouble of marking out the tasks of individuals a second time. The Sappers will take care to preserve the original pickets at the end of every 50 yards, and if the tools should not be arranged quite regularly, one of them who is to remain on the spot, may employ himself in laying them out better, whilst the other goes to meet and conduct a new party to the same ground.

The second relief of men of the Line will parade at the Engineers' Depôt, at such hour as may have been previously fixed. There a part of the Engineer Officers on duty, and one Sapper from each portion of the trenches, will be assembled to receive them. The Engineer will tell off one Sapper

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to each division of 25 men as before: and the whole will be marched by divisions, the Sapper of each party leading it, until they reach the ground allotted for the task of that party.

Preparatory to this arrangement, the several parties being drawn up at the Engineers' Depôt in column, let them be numbered from rear to front, so that the rear division shall now be No. 1, and the front division, if there be 16 in all, shall be No. 16.

In this order let them be made to file off, not in a body, but by divisions, singly, and successively, with an interval of some yards between the rear of one division and the head of another, to prevent confusion; and let each Sapper, acting as a guide, lead his division straight up to that picket, which marks the extreme boundary of the task allotted for it. The stationary Sappers will remain at those same pickets, ready to assist in distributing the workmen, as soon as they shall arrive, and as the head of each division approaches them, they will each call out their respective numbers, that the Officer commanding the division, as well as the Sapper who acts as guide to it, may know whether it is to be halted there or not; which halt will of course take place, as soon as the number of the division shall correspond with that announced by the stationary Sapper.

When thus halted, and fronted, which order should be given at the same time, the men of each division will be made to extend over the whole space of 50 yards, allotted as their respective task, by forming them in single rank, if that should not have been done before, and by causing each man, after facing the whole to the rear if necessary, to extend, until every pair of tools, laid out on the reverse of the trench, shall be covered by a workman.

In this second formation, each party of 25 men will begin to work independently, as soon as they shall be extended on their own ground, without waiting for the others.

It may perhaps appear almost superfluous to observe, that if there should be more reliefs than two required, to complete the parallel, the third relief must be formed precisely in the same manner, that has just been described.

If, under peculiar circumstances, any strong reason should exist against leaving the tools in the trenches, the stationary Sapper will have time enough to mark out each man's task with tracing pickets, during the interval that must elapse between the quitting of one relief, and the arrival of the next: or if such pickets are not at hand, he may extend the new

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working party, by his 6 feet rod, in the same manner as on first breaking ground; but with this exception, that the extension of each party will be performed as soon as it is ready, without reference to the others.

### 7. TIME OF PARADING THE SECOND AND THIRD RELIEFS OF WORKMEN, FOR A FIRST PARALLEL, AND THE APPROACHES CONNECTED WITH IT.

In opening the Trenches it is absolutely necessary to commence at dusk, as the men having no cover, would be too much exposed to the enemy's fire, if such a thing were attempted by daylight. No such necessity however exists, in respect to the second relief of workmen. If therefore a siege should be conducted in any country, at a season when the nights are 10 hours long or upwards, the second relief should be ordered to parade at the Engineers' Depôt, at such time, as will admit of all the necessary arrangements being got through, just before daylight, in order that they may commence filing into the trenches with the dawn; for considering the number of men usually required at this period, in a siege of any importance, and the great extent of ground they are to cover; it appears next to impossible to form the second relief of workmen properly in the dark. Indeed the attempt might lead to inextricable confusion, and it is altogether unnecessary; for after cover is once obtained, the work of half a day, even in the short winter days of temperate climates, is better than that of a whole night. Let it therefore be laid down as a rule, that in the formation of parallels and approaches, the second relief of workmen shall never enter the trenches until at or after daybreak: and that the third relief, when three are employed, shall enter them at noon.

Hence in the long summer days of Northern climates, the periods of relieving the working parties in the course of every 24 hours, may always be at equal intervals of 8 hours, not otherwise.

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# SECTION V.

## RULES FOR TRACING AND COMMENCING THE SECOND PARALLEL, AND THE APPROACHES CONNECTED WITH IT, BY THE FLYING SAP.

### 1. OF THE TRACING.

In commencing the second parallel, one Engineer Officer must be employed in tracing each portion of it, and another in arranging the workmen, on the principle before explained, in treating of the first parallel; but there are several variations in the details of the duty: and in the first place it may be remarked, that the tracing of the second parallel, and of the approaches connected with it, is a much easier task, than that of the first parallel and its approaches.

For example, if we suppose the first parallel finished, and that the second parallel is to be established at any average given distance in front of it, such as 300 yards, it is obvious that the Engineers employed in tracing may mark a certain number of equidistant points, in the first parallel, at any intervals apart, they may judge most convenient, from each of which they may sally out at dusk and measure 300 yards straight towards the Fortress. This will give them an equal number of points in the proposed second parallel, from which they may detach tape-bearers to the right and left, in sufficient number, to overlap each other a little, when they go to the full extent of their tapes. If they do not meet, let the Officer superintending the tracing move backwards or forwards, when arrived at the extremity of one party thus detached, and he will be sure to find the end of the corresponding tape, which was intended to have been connected with it. Then let him cause one of the parties to move their own tape forwards, and the other to move their tape backwards, until they meet, and the error will be corrected; and the tapes for marking the second parallel may thus be laid out with sufficient accuracy, for all practical purposes.

If the second parallel should not be intended to be exactly parallel to the first, it will be obvious, that it may be laid out correctly enough, after consulting the plan of attack fixed upon, by measuring unequal distances, towards the Fortress, instead of equal ones, from the points of departure taken up in the first parallel.

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In measuring distances in a direct line towards the Fortress, and also in tracing a parallel, a star may be assumed as an aid in a clear night, recollecting not to march upon it in a direct line, unless it be the polar star, for more than five minutes, in which time, it will not have changed its position sufficiently to lead to error. When a dark lantern is carried, which must of course be done with the greatest precaution; it has also been suggested, that the pocket compass may be useful, in first starting from one fixed point towards another.

In pushing out approaches from a first parallel, the point, from whence any branch is to commence, as well as the proper alinement of it, may be marked or ascertained in the day time, and such approaches may be traced with white tape at dusk, whilst it is too dark for the enemy to discover this operation, but not dark enough to prevent persons outside from distinguishing the outline of the extreme works of the Fortress, from which the proposed approaches are to be defiladed.

When the approaches are pushed forward in front of the first parallel, as far as the intended position of the second parallel, previously to the commencement of the latter, which arrangement is very common in a siege, the tracing of the second parallel is of course much facilitated. For in this case, all that is to be done, will be to connect the heads of the approaches, with each other by a line of white tapes, the proper direction of which may be ascertained beforehand in the day time.

### 2. OF ARRANGING THE WORKING PARTY, AND COMMENCING A SECOND PARALLEL BY THE FLYING SAP.

When a parallel is said to be commenced by sap, it merely implies that gabions are used. The peculiar manner of working with them, described in this article, is called the flying sap.

The workmen ordered for the duty of commencing, or as it is also termed, of opening the second parallel, will parade at the Engineers' Depôt, to receive their tools and gabions, in divisions of 25 men, who must be formed in column in single rank, in the manner before directed.

Every man is to carry a couple of 2 feet gabions, holding them under his arms, by means of a picket, 2 feet 9 inches long, driven transversely through each of them, about 15 inches from the top, which pickets he grasps in his hands.

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In one of these gabions he also carries a pickaxe, and in the other a shovel, as shown in the annexed figure. The iron part of the shovel, and likewise of the pickaxe, are secured by pushing them in front of two of the picket ends, which project above the web on one side of the gabion, whilst the adjoining part of the wooden helve of each tool passes between the same pickets, and the remainder of it hangs obliquely down, towards the opposite side of the gabion.

The implements necessary for each division, consisting of 50 gabions, with a transverse picket driven through each, and with a shovel and a pickaxe fixed in each alternate gabion, must therefore be previously laid out at the Engineers' Depôt in successive lines, at central intervals of about 4 feet apart, so as to suit the formation of the column. In fixing the pickaxe and shovel, after the pickets are driven, care must be taken to arrange them in such a manner, that their helves shall not be so placed, as to prevent a man's arm from getting conveniently at the pickets inside of each gabion. The Sappers at the park, employed in laying out the tools, must be strictly cautioned as to this head, and ought to lift up in succession each pair of gabions, by way of trial, after the pickets and tools are fixed, shifting the latter, if improperly placed.

After receiving their tools, and gabions, the whole working party must advance by files, in single rank, to the point from whence they are to extend; on reaching which, they will be formed along the line of white tape, previously laid in the manner before directed, excepting that no measuring rods are necessary in the flying sap, for the two gabions carried by each workman serve to measure his task.

As they come up into their proper places on the reverse side of the white tape, each man will successively put down his two gabions close together, in front of the line, so as to clear it by two or three inches.

The Sapper who assists in superintending the extension, is to correct the position of every successive pair of gabions, which it is difficult for the workman himself to place properly, on setting them down. The Engineer Officer directing will take care to enforce accuracy, and to prevent hurry or confusion. As soon as each workman has got his gabion placed, by assistance of the Sapper, he will disengage his tools, and pickets, as it is useless to waste the latter by leaving them in the gabions. They may be laid down in rear of, and close to the gabions. The tools must be laid down behind the two gabions, which mark each man's task, in the manner before described in treating of the first parallel.

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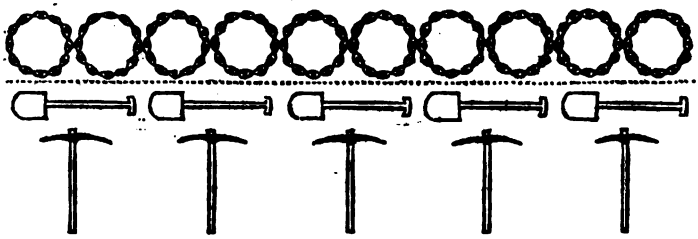

The above figure represents this arrangement, showing the manner in which the gabions and tools of five workmen are placed, the former in front, the latter in rear of the white tape.

Whilst the extension of the whole working party is thus going on progressively, the men first posted will sit down behind their own gabions and tools, as soon as the latter are properly laid out, and will wait the order to commence work in perfect silence, which will be passed on from the extreme points of the parallel, as soon as the whole operation shall be completed.

Every man will then commence digging in rear of his own two gabions, which he will fill with all expedition, patting the earth well down before he throws any part of it over. A good workman may fill his gabions in from 10 to 15 minutes, after which they will be musket proof, every where excepting in the intervals between two.

### 3. OF TRACING AND COMMENCING APPROACHES BY THE FLYING SAP.

The approaches in front of the second parallel, and sometimes even those immediately in rear of it, are commenced by the flying sap.

The method of tracing them is precisely the same, as if no gabions were used, and has already been explained in article 3 of the preceding section. The method of extending the workmen, and of commencing approaches by the flying sap, is the same, as in commencing the second parallel.

In tracing approaches, which are to be executed by the flying sap, it is unnecessary to cut the tape, for the purpose of forming a return. Instead of which, let four pairs of gabions be moved from the head of each branch, adjoining to an angle, and placed in prolongation of the next branch in front of it.

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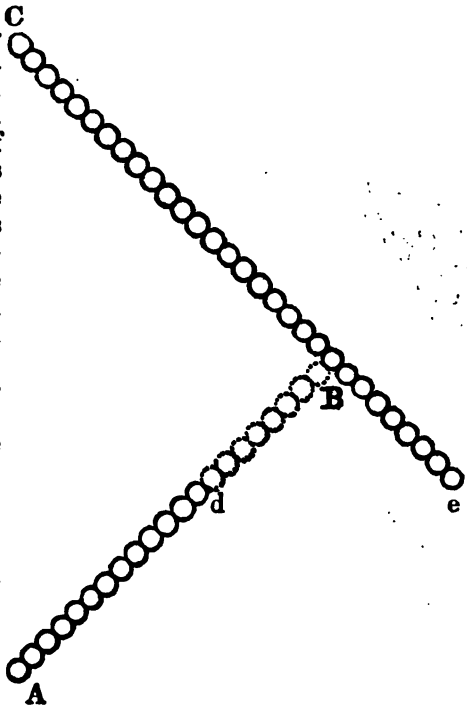
Thus for example, in the annexed figure, if A B, and B C be the original form of an angle of the zig-zags, as traced by the white tape, the four pairs of gabions, originally placed at the head of the branch A B, are removed from the position d B to B e, where they are placed in prolongation of the advanced branch B C, produced towards the rear; and thus they form the return, at the angle B.




### 4. OF THE PROPER TIME FOR PARADING THE SEVERAL RELIEFS OF WORKMEN FOR THE SECOND PARALLEL, AND THE APPROACHES CONNECTED WITH IT.

The proper periods for the relief of the workmen must be regulated, precisely on the same principle, as those of the first parallel.

I before named at least an hour and a half before sun-set, as the parade time of the first relief at the Engineers' Depôt. It is possible, that the necessary arrangements may be made in rather less than this time; but I have doubts on the subject: and one thing is certain, that it would be better for the working parties to be kept waiting an hour longer, than the time actually required in those preparations, than that they should be 10 minutes too late: for if the dark should surprise them before the necessary arrangements are fully completed, the whole night's work may be lost in a scene of inextricable confusion.*

* At the Siege of Flushing, when I was the executive Engineer on duty of the first relief, with my brigade, a night's work of about 500 men was entirely thrown away, from this cause, to my extreme mortification.

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Whatever system may be decided upon for carrying the gabions and tools, for there may be several others, besides that which has just been described, it is of the most essential importance, that every thing shall be completely prepared beforehand at the Engineers' Depôt; so that whatever materials and tools shall be assigned to each individual of the working party to carry, shall be put together and laid out for him, in good order, without giving him any trouble in what belongs to arrangement. Unless this system be adopted, for facilitating the commencement of the work, it might take the whole afternoon to get through the preliminary arrangements.

For the same reason before stated, the formation and distribution of the second relief of the working parties of men employed in the execution of a second parallel, or of the approaches connected with it, should not be attempted till daylight, when it will be comparatively easy.

Let it be understood, that the same necessity does not exist for waiting till daylight, before the second relief are set to work, in the other operations of the siege, in which when the nature of them shall come to be explained, it will be evident, that there is much less risk of confusion; for the men are either more concentrated on particular spots, as in the construction of batteries, or more subdivided, at the same time that fewer are employed, as in the execution of the final operations of a siege, most of which are commenced by the regular sap, or by mining.

## SECTION VI.

### VARIETIES THAT MAY BE ADOPTED, IN THE MODE OF COMMENCING THE SECOND PARALLEL, AND THE APPROACHES CONNECTED WITH IT, IN LIEU OF THE ARRANGEMENTS SUGGESTED IN THE PRECEDING SECTION.

#### 1. ANOTHER METHOD OF CARRYING A COUPLE OF GABIONS.

WHEN a man is only required to carry one gabion, he naturally takes it on his shoulder, but when he is called upon to carry two, some embarrassment is occasioned, more by their figure, than by their absolute weight. As it is well known, that a man can carry a greater weight on his shoulders, than

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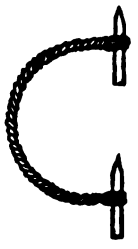
in his hands, with his arms down; the following method of carrying two gabions has therefore been suggested for long distances,* as an improvement on the former, which will answer extremely well for short distances.

This consists in forming a loop to each gabion, about 9 inches in height, and equidistant from the top and bottom. This may either be made of a withe, or of a piece of 2 inch rope, about 2 feet long, with a wooden toggle, about five inches long at each end, round the middle of which the rope is spliced, as shown in the annexed figure. These toggles being passed into the inside of the web of the gabion, whilst the bight of the rope is outside, serve to attach it to the gabion.



In preparing to carry a couple of gabions thus fitted, a man passes his arms through the loops, and takes them up exactly like a knapsack, previously, however, connecting them together by a small withe, or a piece of spunyarn, to prevent them from separating. This precaution being taken, a man may transport a couple of gabions on his back with ease, whilst his hands are left free to carry his tools, as shown in the annexed figure.

This method of carrying a couple of gabions is the best when the mere labour of that operation is considered, but it would not be easy to make the final extension and arrangements of a line of workmen when thus loaded, so conveniently as in the former method; for they must turn their backs to the line traced out by the white tape, and stoop down nearly to the ground, in setting down their gabions, which they can scarcely disengage without assistance, and thus the operation will be attended with more trouble and delay.†

I am therefore inclined to think, that this method should be adopted only by parties ordered to carry gabions from the Engineers' Depôt to the reverse of the trenches, to be deposited there in readiness for other workmen, who are destined to place and fill them; as is generally the case in the regular

* Suggested by Captain Macaulay, R.E.

† After gabions carried by this method are finally placed, the toggles must be saved, and sent back to the Engineer's Depôt.

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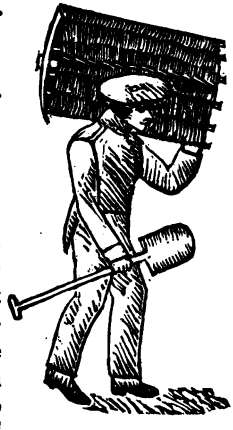
sap, and in the other operations towards the close of a siege, when one set of men usually carry the materials, whilst others use them.

### 2. SECOND METHOD OF COMMENCING THE SECOND PARALLEL.

It being considered that it may be too fatiguing for men to carry two gabions to any distance, and to work immediately afterwards, the following arrangement may be adopted, for expediting the formation of a second parallel by the flying sap.

Under the supposition, that there are three reliefs of men to be employed in the 24 hours, let two of those reliefs parade together, at the Engineers' Depôt, each being formed into divisions of 25 men.

Let the gabions at the Depôt be laid out in successive lines of 50 gabions each, with an interval of 5 or 6 feet in the center of each line of gabions. Let a pickaxe with the iron upwards, be fixed upon each of the 25 gabions, to the right of the center, and let a shovel be laid out in rear of each of the same gabions.



These arrangements having been previously made, let the divisions of the working party be formed up in rear of the gabions, in column of grand divisions, the divisions of the first relief being all on the right, and those of the other relief all on the left of the column. This being done, let them take up their gabions and tools. Each man must carry his gabion on the left shoulder, with the original top of the gabion to the rear. This will prevent the pickaxes attached to a part of the gabions from dropping out, as the gabion is naturally carried higher in rear than in front.* Those men who are also to carry shovels, will trail them in the right hand with the iron to the front, as shown in the annexed figure. A Sapper must fall in, on the reverse flank of each grand division.

When all are ready, let them be filed off by grand divisions, until they reach the proper point in the proposed Parallel, where they must be made to form up to the right

* The point of the pickaxe may be run through the web near the top of the gabion, for greater security, if you think proper.

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or left, each man placing his gabion in succession, along the alinement previously marked by the white tape.

The Sapper attached to, and leading each grand division, will assist in placing the gabions, under the superintendence of the Engineer Officer, who will see that it is done in good order, and without hurry: and when the 50 gabions of each grand Division are placed, he must mark the extremity of this position, by driving a white picket, or by means of some other conspicuous object.

According to this arrangement, the whole ground to be occupied by the proposed Parallel will be covered by a line of men, one to each gabion. As soon as the rear of any part of the line shall be clear, the Officers in charge of alternate divisions, namely, those which did not bring out tools, will march their parties out of the trenches, to their own respective camp or cantonments. Thus one of the two reliefs of the working party, that came on the ground together, will be dismissed, whilst the other, namely the first relief, will be left to commence the trench.

When alternate divisions shall have been marched off, as before stated, one half of the line of gabions will be left uncovered, at equal intervals throughout the whole extent of the proposed Parallel.

The men of each remaining Division, must therefore be made to extend themselves in the usual manner, all to the right, or all to the left, as may be required, until, instead of each covering his own original gabion, they shall cover alternate gabions along the whole space, of which one half had at first been left blank.

Preparatory to this extension, each man will disengage his pickaxe from the top of his gabion, as he must carry both his tools with him, in moving.

When the extension shall be completed, there will be one man to every two gabions, in readiness to commence the Parallel, which will be done in the manner before explained, on the order to that effect being passed on from the extremities of the line.

### 3. RULES FOR ARRANGING THE SUCCESSIVE RELIEFS OF WORKMEN, ACCORDING TO THE ABOVE METHOD.

If the above method of commencing a second Parallel by the flying sap should be adopted, the first relief, and that which ought to be the third relief of the working parties, should go on duty together: and as soon as all the gabions shall be placed, the third relief should retire, leaving the first

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relief to commence the trench. And in consequence of this extra tour of duty, falling upon the third relief, the tasks of the several parties should be so arranged, that the second relief of workmen should nearly finish the Parallel, leaving only a very small portion of the work to the third relief, when, contrary to the usual practice, they shall return to the trenches a second time, within the course of the four and twenty hours.

The second relief of workmen, will be arranged precisely according to the same manner, as was before described for a second Parallel, commenced by the former method. Drawn up in Divisions of 25 men each, they will be filed into the trenches, and there extended, so as to cover every second gabion, taking up and using the tools left by the men of the former relief, which will be arranged in good order for this purpose, by the Sappers left in the trenches.

### 4. THIRD METHOD OF COMMENCING THE SECOND PARALLEL.

The method now alluded to, is that which was generally used in the Sieges in the Spanish Peninsula.

The men of the working party worked by pairs, one man carrying a pickaxe, and his comrade a shovel, and each carrying a gabion.

After the gabions were placed, one man loosened a quantity of earth with his pickaxe, which the other threw up with his shovel; and so they proceeded to fill their gabions, and form the parapet, one man working in his turn, whilst the other stood still. Thus one half of the working party only, were in a state of activity at the same time.

This arrangement certainly exposes to the enemy's fire, double the number of men, that can work to advantage: for we have found in our field works at this Establishment, that whenever a line of excavators has been crowded into a smaller space than 4 feet per man, which we consider the minimum space, that ought to be allowed; that instead of expediting the work, it has retarded it; for being in each other's way, and in danger of being wounded by each other's tools, which has occasionally happened even in working by daylight, a part of the men have necessarily stood still, and much confusion has ensued, which would of course have been considerably aggravated, had men thus crowded been employed in the dark, and under an enemy's fire.

Notwithstanding this objection, as the method now under consideration was acted upon, and appears to have given

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satisfaction in the Sieges in Spain,* I shall not presume to decide against it. The following measures may however be adopted for conducting it with good order, and with a view to avoid confusion, as much as possible.

It being understood, that there are usually three reliefs of men employed in the four and twenty hours; let the first and second reliefs parade together at the Engineer's Depôt, preparatory to the commencement of the second Parallel, and for this night in particular let them be formed in Divisions of 50 men, instead of 25 men each; but without intermixing any of the divisions of one relief, with those of the other, as in the second method of performing this operation which was before described.

In this order, let the men of every division carry 50 gabions, and 50 tools, one tool per man, the latter to be a pickaxe and shovel alternately. Each gabion will be carried on the left shoulder, whilst the tool is trailed in the right hand; or *vice versa*.

After all the gabions are placed, and the rear of each division clear, let every alternate man of the working party be directed to leave his tool resting against his gabion, and to retire about three paces from the line of gabions. and there sit or lie down in readiness, when required to relieve the others, who will commence digging the trench and filling the gabions, with all expedition.

Thus whilst 25 men of each division will rest, the remaining 25 men will work, in line, at intervals of 4 feet per man, which is rather more crowded than one would wish, but not inconveniently or dangerously so, provided that the unemployed men keep out of their way, for which as I observed a few paces are sufficient. When the first parties are tired, let those who were at rest be ordered to relieve them, the former in their turn lying down a few paces in the rear of the line of gabions, whilst the latter continue the trench.

By this method, if one half of the men relieve the other half at intervals of not less than half an hour, they may push the work forward with much more vigour, than if a smaller number were employed: and therefore these two reliefs should be required to finish nearly two thirds of the parallel between them, before they are allowed to quit the ground.

In relieving each other by alternate half divisions of 25 men, those men who are to be relieved, must be strictly charged, not to throw down their tools in the dark, but to deliver them personally to the others who are to take their place.

* See the first Edition of Colonel Jones's Journals, Note 16.



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In employing men in this manner, the strictest orders must be given to prevent those men who are at rest, from getting into the trench, and mixing with the workmen, which, if permitted will occasion such confusion as must paralyze the work altogether: and then instead of deriving any benefit from the employment of more men, the hazard of casualties from the enemy's fire will be doubled, whilst the quantity of work done will be diminished in proportion to the excess of men, thus uselessly and disadvantageously huddled together.

Supposing that no such confusion occurs, and that the work proceeds in good order, the two reliefs of men thus employed will be permitted to retire, after finishing their task, which ought to be nearly two thirds of the proposed parallel, as was before stated. They will leave their tools on the reverse of the trench as usual, which will be collected by the Sappers, and arranged in pairs behind every second gabion.

The third relief of men, having been previously drawn up in divisions of 25 men each, will be filed into the trenches, and extended so as to cover every second gabion, in the manner before described; after which they will begin work, and it will be their duty to complete the parallel, each man having a task of about 4 feet marked by two gabions.

### 8. REMARKS ON THE THREE FOREGOING METHODS, OF COMMENCING A SECOND PARALLEL, BY THE FLYING SAP.

The first method described in the preceding section, would undoubtedly be the best, if the men could carry two gabions and their tools without over fatigue: for after the completion of the extension, and the placing of the gabions along the line previously traced, no more men would be collected, than could work together to advantage, and without confusion. The distance from the usual position of the Engineer's Depôt to that of the second parallel in a siege is however such, as would probably exhaust any but very robust men, inured to labour, if loaded with two gabions each as well as with tools; and although the second method of carrying gabions above described by slinging them on the back is less fatiguing, yet as I before observed, it would be much more difficult to form the men, and place the gabions in proper line, after the latter have been thus carried.

If instead of collecting them at the Engineer's Depôt, the whole of the gabions for the opening of a second parallel

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could be carried to the reverse of the first parallel, and laid out there, which might be done previously, by one of the reliefs of the guard of the trenches, all ready for the working party; the distance from thence to the usual position of a second parallel is not so great, but that each workman might carry a couple of gabions and a pair of intrenching tools so far, without extraordinary fatigue; especially as the second parallel would be commenced from more points than one, in order to expedite and shorten the process, of the extension and formation along that line.

It is possible however, that some practical objection might occur, to making the first parallel serve as the depôt, for the gabions and working parties intended for the opening of the second parallel, which the Engineer employed in a siege would be able to judge of, on the morning previous to that operation, but which one cannot well decide upon at an establishment like this, nor perhaps anywhere excepting on the spot.

If any strong objection to that arrangement should occur, I apprehend that it would be necessary, to give up the first method altogether; and to resort to the second or third methods also before explained.

In considering the comparative merits of the latter, the second method would get rid of all confusion, and I am inclined to believe that it would be the best, but as I do not think that it has ever yet been tried on service, I shall not presume to speak with confidence. The objection to it is, that one of the two reliefs of men employed at the same time shall be called upon to do so little, as merely to deposit each a gabion on the ground allotted for the second parallel, and go away; it being considered, that the marching backwards and forwards and the previous formations of the working parties in a siege, are often attended with considerable fatigue; and therefore it may be said, that it is not worth while to harrass a body of men, by sending them into the trenches at all, unless they be kept there, until they shall have executed a proper task, of from one third to one half of a parallel or approach.

In the third method proposed, both of the reliefs of men employed together are detained, until they execute a proper quantity of work; but as I have observed, there is great risk or rather a certainty of this object being frustrated, unless each half division shall in its turn lie down in rear, and out of the way, whilst the other half division is working in the



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trench. Now a query may here occur, whether as many casualties may not arise, from prohibiting the men at rest, from taking shelter in the trench, as if the parallel had been commenced entirely without gabions, by only one relief or half the number of men, instead of two reliefs. If this observation has any weight, may not upon the whole, the second method be considered more advantageous than the third ?

The difficulties, for such there are, in commencing a parallel by the flying sap, when a great body of men are to be employed, which arise solely from the size of the gabions, are such as probably gave rise in former times, to the use of 3 feet gabions, as being better adapted to mark the task of one workman, than a smaller gabion would be. But this expedient would not remove the evil, for a line of workmen is too crowded even at intervals of 3 feet, and the use of such very large unwieldy gabions would be attended with the greatest disadvantages, in every other respect. For the regular sap, in particular, they would be nearly useless.

Having described the various methods, that may be adopted for commencing a second parallel or approaches, on an extensive scale by the flying sap, but without presuming to give any decided opinion on the subject, I shall remark, that if all had been tried on service, it is probable, that no doubt would remain as to which method was really the best; but I am inclined to believe, that none but the third method has as yet been carried into execution in war. It would however in all probability be a very easy task, for any Engineer to decide upon these matters in a siege, although it is difficult to make up one's mind, by merely reflecting on the subject, or by trying experiments with intelligent men, inured to labour, like the Sappers at this establishment.

Whatever variety may be adopted in commencing a second parallel by the flying sap, in regard to the numbers and arrangement of the men employed; there can be no reason for following such variety, in respect to the next reliefs of men who are to continue the trench.

Accordingly I have supposed each division of the second and third reliefs to consist of 25 men, whose task is marked by a space of ground covered by 50 gabions, that is at the rate of 2 gabions or of about 4 feet per man.

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# SECTION VII.

## OF ARMING THE WORKING PARTIES IN A SIEGE.

### 1. WHETHER WORKING PARTIES IN A SIEGE SHOULD BE ARMED, OR NOT.

It appears to me, that the working parties employed in opening the trenches on the first night of a siege, ought not to carry their arms with them. They must necessarily be protected by strong covering parties, destined for the special duty of repulsing sorties. To call upon the working parties also to assist in this service, would only create confusion without adequate benefit; for they are spread over so great an extent of ground, that they could scarcely collect their arms and form, in sufficient time to be of much use; and if once formed as a military body, no more work could be expected from them. In the event of sorties therefore, they should remain at their post, if sufficiently protected by the covering parties. If not, let them be ordered to take up their tools, form by divisions, and in that order file independently to the rear, each division being always collected as an organized body, under its own Officers, ready to return to its post in the trenches, on receiving orders to that effect.

This remark applies chiefly to the first parallel, and to the approaches in rear of or near to it. But when the operations are more advanced, as in the second parallel, and in other parts usually commenced by the flying sap, the working parties being now much nearer to the fortress, may be allowed to take their arms, in order to give them confidence; but they should carry the musquet and bayonet only, without accoutrements, because it is impossible for men to work with their accoutrements on; and if they take them off, they could not put them on again, and adjust them, in proper time, in the event of a sudden sortie; besides which the men of the working parties, if provided with accoutrements could not be distinguished from the guards of the trenches; and thus lazy or ill disposed individuals might often have an opportunity of skulking from their work, for a great part of the night, without detection. The working parties when armed should therefore only carry a few ball

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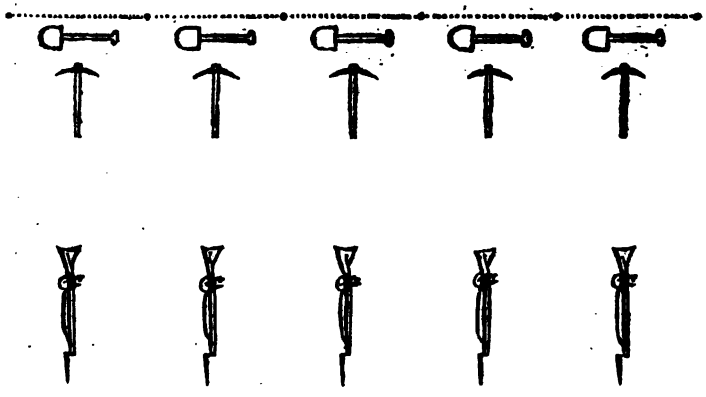
cartridges in their pockets, and they should not even be allowed to take their bayonet scabbards with them, which might be liable to be lost.

### 2. METHOD OF ARRANGING WORKING PARTIES WITH ARMS, WHEN THEY COMMENCE A PARALLEL OR APPROACH WITHOUT GABIONS.

In all cases when working parties are to carry their arms, they should sling them behind their backs, after the fashion of the old British Grenadiers, that is with the sling all to the front of the body over the right shoulder, and under the left arm, and with the firelock behind, the butt downwards and muzzle upwards; and as accoutrements are not to be carried, the bayonet should previously be fixed. In this order they will march to the Engineer's Depôt and receive their tools, which they will be able to carry with ease, as both their hands are at liberty. As soon as the extension shall be made, behind the line of white tape, which must be done precisely in the same manner, whether arms are carried or not, and which was before described in Section IV, Article 2, each workman after laying down his tools in their proper position, behind the white tape, will unsling his firelock: and afterwards, when the ground behind him shall be clear, in consequence of the remainder of the working party having moved on, he will march three full paces to the rear and ground his arms, in the manner shown in the annexed figure, in which the dotted line represents so much of the line of white tape, as is sufficient to mark the ground occupied by 5 workmen.



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### 3. METHOD OF ARRANGING WORKING PARTIES WITH ARMS, WHEN THEY ARE TO COMMENCE A PARALLEL OR APPROACH BY THE FLYING SAP.

*Case I.*—When the men are to carry two gabions each, as well as tools, under a supposition that the distance is short.

In this case, the tools and gabions are to be arranged beforehand, by pairs, in the manner before described (in Section V, Article 2,) a picket being driven through the gabion to carry it by.

The men of the working party, having their arms slung behind their backs, with bayonets fixed, will carry their gabions and tools, as shown in the annexed figure, and they will place the former, and lay down the latter, after being extended, in the manner explained in the same article; and when this is done, each man will unsling his firelock, and afterwards ground it, three full paces in rear of his own tools, as directed in the preceding article.

When the men of the working party are armed, it is impossible for them to carry two gabions on their backs, knapsack fashion, in the manner explained in Section VI, Article 1.

*Case II.*—When each man is to carry one gabion only, and his tools, as in the second and third methods of opening the second parallel before described.

Having his firelock slung behind, with the bayonet fixed, each workman will carry his gabion on the left shoulder, and trail his tool in the right hand, if only one tool is to be carried. But if each man should be required to carry a pair of tools, besides a gabion, the pickaxe must be attached to the gabion, in the manner before described in Section VI, Article 2, and both carried on the left shoulder, whilst the shovel will be trailed in the right hand.

After being properly extended, each man will lay down his tools, and unsling his arms, and when the rear of his division is clear, he will ground the latter three paces behind the white tape, as explained in the preceding article.

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### 4. ANOTHER MODE OF CARRYING THE ARMS OF A WORKING PARTY, WHO ARE TO COMMENCE A SECOND PARALLEL BY THE FLYING SAP, ACCORDING TO THE SECOND OR THIRD METHODS BEFORE DESCRIBED.

The mode, now about to be explained, is that which was adopted, in the sieges in the Spanish Peninsula.*

Five workmen out of six carried each a gabion, and a tool, whilst every sixth man carried the arms of the other five, and took the place of those who might be disabled by the enemy's fire.

I must confess, that this arrangement does not appear to me so good, as the methods before proposed. It is certainly better, if it can be so managed, that every soldier shall be responsible for his own firelock; and as the arrangement of one man to every gabion crowds the workmen twice as close together, as they ought to be, in commencing a parallel, the addition of one man more to every five, they being already thus crowded, must of course greatly aggravate the evil. Even if one half of the men should be sent away, after the line of gabions is placed, as was before proposed, in the second method of commencing a parallel by the flying sap, the remaining men who are to execute the parallel, are still rather closer together than one would desire, in commencing the excavation of a trench: and therefore, even in this case, any increase to their number may be considered disadvantageous,

### 5. FURTHER REMARKS ON THE ARMING OF WORKING PARTIES.

It was before stated, that the working parties who open the trenches, on the first night of a siege, should not be allowed to take their arms, considering the very extended order in which they are formed for work, and also their distance, from the fortress. It is to be remarked, however, that the chief objection to taking their arms is the former circumstance, of their being so much dispersed. But if a greater number of men be concentrated on one spot, as in the construction of large batteries, redoubts, or intrenchments, the working parties may be allowed to take their arms: for in this case, a considerable body of men may be speedily formed to repulse a sudden attack, who might afterwards resume their work without much confusion, as they would probably be able to maintain their ground, without retiring to the rear.

The propriety of this arrangement will be obvious, by

* See the first Edition of Colonel Jones's Journals, Note 16.

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considering that a ten gun battery alone might give employment to nearly 200 men, within a space of about 80 yards, whereas in a first parallel the same number of men would be spread over an extent of 400 yards.

Even in this case, accoutrements and bayonet scabbards ought not to be taken for the reasons before assigned.

## SECTION VIII.

### RULES FOR EXECUTING THE FIRST PARALLEL, AND THE APPROACHES CONNECTED WITH IT.

THE methods of arranging and distributing the workmen in commencing the first and second parallels, and the approaches connected with them, in a siege, having now been fully discussed, it remains to explain the nature and execution of those works in detail, which together with some remarks, on the best mode of superintending military working parties, will form the subject of the present section.

#### 1. OF THE PROFILE PROPER FOR A FIRST PARALLEL.*

The Profile usually adopted by us of late consists of a trench 11½ feet wide at bottom, 3 feet deep in front, and 3½ feet in rear, with a reverse slope having a base of 3½ feet being equal to its height, and with a step of made earth 1½ foot wide at bottom and 1½ foot high, added to the front of the original trench when half finished, which therefore reduces the net width of the sole of the trench from 11½ to 10 feet.

The earth of the trench, being thrown forward towards the fortress attacked, forms the parapet of the parallel, which is not rammed.

A berm of 1½ foot is left between the front of the trench, and the base of the interior slope of the parapet, which serves as a banquette, to fire over the parapet, which on being left to take its own form usually proves to be about 5 feet high, after the trench is finished. The inside of the parapet should then be smoothed, the berm widened if necessary, and any unseemly irregularity in the height of the parapet should be removed, but it is not worth while to cut it generally lower, than the form, which it may naturally assume: and if therefore its height should be too great to fire over conveniently, let a small narrow step be cut on the interior slope a little higher than the berm, for a man to stand upon, whilst firing.

* This profile is illustrated by the figure afterwards given in page 60.

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A regular banquette, like that of more permament works, is considered unnecessary.

## 2. GENERAL REMARKS ON THE TASKING OF MILITARY WORKING PARTIES, IN THE FORMATION OF A FIRST PARALLEL.

By repeated experiments at Chatham, tried with the utmost care, we found that a portion of parallel of the dimensions above stated, which involves 261 cubic feet, or 9⅔ cubic yards of excavation, may be completed in an average of 5 hours per man in soft soil, which requires little or no picking, and in an average of 9¼ hours per man, in hard soil.

The most difficult soil that we could possibly find in this neighbourhood, which consisted of a concretion of flint-gravel, sand and clay, required an average of 10½ hours. In all those experiments, the task of each man was two yards in length; and we are of opinion, that a shorter portion of trench work ought in no case to be allotted to individual workmen, on the night of opening the trenches in a siege. For as was before observed, if men be crowded into too small a space; they are liable to wound each other with their pickaxes, and finding that they are in each others way, a part of them will be tempted to stand still; and thus by increasing their numbers beyond a certain proportion, the casualties from the enemy's fire will of course be increased, without obtaining a proportional increase in the quantity of work performed.

The sappers employed in those experiments were generally artificers, not previously inured to labour, with the pickaxe and shovel, until they joined this Establishment, and not by any means more robust men, than the British Infantry usually are. It is evident, that many intermediate qualities of soil may occur on service, between the soft soil, which required only an average of 5 hours labour, and the very hard soil, that required 10½; and of course in employing workmen of the same physical powers, and dexterity, the time for completing a parallel might vary, between the minimum average of 5 hours and the maximum of 10½ hours. In those experiments, the men were tasked individually, and in all cases some got through their task in nearly half the time of others; but in the very worst soil, the time of the slowest workman did not exceed 13¼ hours.

In tasking a working party of the Line, on service, the task of 50 yards for each party of 25 men ought to be general, not individual; for although a good workman may do twice as much as a bad one in the same time, yet if both do their best, it will be no greater exertion to the one than to the

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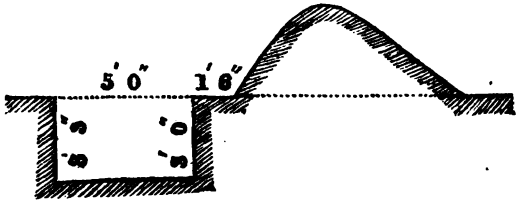
other; and when a whole party of soldiers are jointly responsible, they will scarcely allow any one man to evade his due share of the work.

### 3. FIRST TASK, IN EXECUTING A FIRST PARALLEL BY THREE RELIEFS.

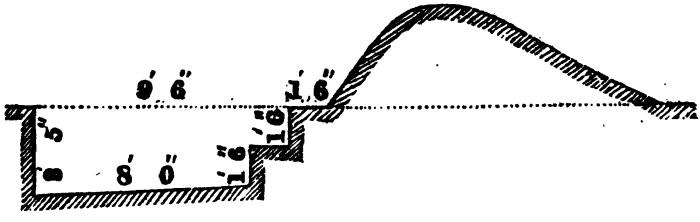
Considering that the first relief of workmen in a siege are more harrassed by preliminary arrangements, than the others who succeed them, whilst they cut their trench to the standard length of 6 feet, let them make it 3 feet deep in front, 3 feet 3 inches deep in rear, and 5 feet wide from front to rear, as shewn in the annexed figure.




The above will amount to 93¾ cubic feet, which is nearly but not quite equal to 3½ cubic yards of excavation, which may be executed by able bodied men, with moderate exertion, in from one hour and three quarters, to three hours and a half, or four hours, at the utmost. It really would be trifling with the service, to allot a smaller task than the above, to any set of men, deserving of the name.

### 4. SECOND TASK IN EXECUTING A FIRST PARALLEL BY THREE RELIEFS.

In this task, an equal number of men being employed at the standard rate of 6 feet to each man, as before, let the trench be widened by cutting it 4 feet 6 inches more to the rear, which would make 9 feet 6 inches wide in all, but for a step of 18 inches in width in front of the trench, which is formed by this set of men, and which reduces the net width of excavation, at the sole of the trench to 8 feet, as represented in the annexed figure. The depth in rear must be increased to 3 feet 6 inches.

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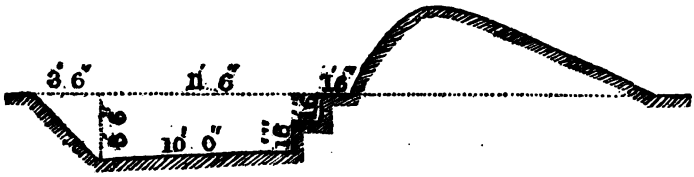
This task involves exactly 3½ cubic yards of excavation, being a little less than the former, but the distance to throw the earth is greater, and on the whole it is somewhat more laborious than the former task, and is made purposely so, for the reason before implied; namely that the men of the second relief are exempted from those preliminary arrangements, that fall to the lot of the first working party.

### 5. GENERAL DESCRIPTION OF THE THIRD TASK, IN EXECUTING A FIRST PARALLEL BY THREE RELIEFS.

In this task, an equal number of men being still employed, at the standard rate of 6 feet to each man as before, let the trench be widened, by cutting 2 feet more to the rear, which will complete the sole of the trench, making it 3 feet 6 inches, in extreme depth. This being done, let the reverse slope of the trench be formed at an angle of 45 degrees, making the base of the slope 3 feet 6 inches, being equal to its depth.




The quantity of excavation in this task amounts to about 78¼ cubic feet, which is equal to 2⅞ cubic yards only, but owing to the great distance, that the earth must be thrown to clear the parapet, which cannot be done at one heave, as in the first task throughout and in part of the second task; and owing also to the necessity of causing this party to make a complete finish of the work; by putting every thing in order, trimming the parapet, widening the berm, forming a small step as a banquette on a higher level, if required, besides securing the trench against rain, in the manner that will be described in the next article; I conceive that this task will probably require rather more time than either of the two former tasks, to bring it to a conclusion, but it is not a more trying operation, as the men have the advantage of being well covered when they begin. The annexed figure represents the profile of a finished parallel, such as has been described.

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6. REMARKS ON PRESERVING THE TRENCHES DRY. THAT THE WORK NECESSARY FOR EFFECTING THIS OBJECT, IN A PARALLEL EXECUTED BY THREE RELIEFS, SHOULD FORM A PART OF THE THIRD TASK.

When the ground is marshy, it must of course be exceedingly difficult to preserve the trenches dry, in a siege; but when the evil only arises from heavy and continued rains, the following measures must be adopted, in order to effect that object, the execution of which should form a part of the task of the third or last relief of workmen.

Let drains be cut from the reverse of the trenches into all valleys or hollows, which by being on a lower level can carry off the water; and let sesspools of about 2 feet square, and a foot or two lower than the sole of the trench be made in the reverse thereof, at intervals of about 50 yards; not however making such sesspools exactly equidistant, but in all low points where the rainwater shows a tendency to stagnate. They must be cut entirely in rear of the trench, so as not to diminish its regular width, and the sides sloped if necessary, to prevent the earth from falling in.

Sesspools of this description will keep the trenches as dry as can be expected; but in excessive rains it may be necessary to bale out the water occasionally, for which purpose shovels will answer.

In short the rule to keep a trench dry in rainy weather is, to take such measures, as to prevent it from becoming a drain to the neighbouring ground, which would from time to time convert it into the channel of a torrent.

Nothing therefore but the rain, which falls vertically down upon the trench itself should be admitted, and this surface water, which cannot be excluded, will never annoy the troops in any considerable degree, provided that the above mentioned precautions, of cutting sesspools at intervals and of occasional baling, be resorted to. The rear of the sole of the trench may also be cut in the form of a small drain, from sesspool to sesspool.

The execution of the arrangements described in this article must generally be made a part of the task of the third or last relief of men, employed in finishing any portion of the trenches.

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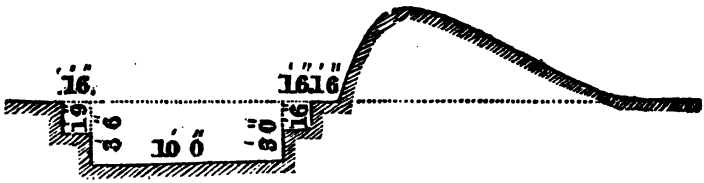
### 7. FURTHER REMARKS ON THE EXECUTION OF PARALLELS. THAT EACH RELIEF OF WORKMEN SHOULD BE ALLOWED TO QUIT THE TRENCHES, ON FINISHING THEIR TASK, TO THE SATISFACTION OF THE ENGINEERS ON DUTY.

As a matter of mere labour, it would evidently be better to cut the front step of the trench out of the solid ground, instead of forming it afterwards, with loose earth from the rear: but as the first working parties have to work in the dark, often exposed and always expecting to be exposed to fire, it is of importance to simplify their task as much as possible, which cannot be more effectually done, than by the arrangement of leaving the step to be formed afterwards, by the second relief, who at this period will have the advantage of working by daylight.

Sometimes we have formed our parallels, with a reverse step, instead of a slope in rear, making this step 18 inches in width, and equal in height to 1 foot 9 inches, or to one half of the extreme depth of the trench, as shewn in the annexed figure.




This construction, which diminishes the labour of the third task by 21 cubic feet, or $\frac{1}{4}$ths of a cubic yard, is quite as good as the former, excepting for the passage of carriages, which enter into or issue out of a trench, more conveniently by means of a slope, than by steps.

When the working parties have a given task allotted to each relief, which in the construction of parallels and approaches is the best arrangement, or rather indispensably necessary; each party of 25 men should be allowed to quit the trenches, as soon as they shall have finished their task to the satisfaction of the Engineer on duty, who must of course previously ascertain this point by actual measurement, in which he will be assisted by the sappers of the division: and in so doing he should be very strict, rather measuring over than under; for as all the tasks are easy, it would not be fair to throw any part of the labour of the first,

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upon the second, or of the second upon the third relief of workmen.

In case of any gratuity having been promised to the working parties by the General commanding, for the execution of a particular work, it should never be granted without a certificate in writing, from the Engineer on duty in the trenches, that they finished their task to his satisfaction.*

8. OF THE BEST MODE OF SUPERINTENDING MILITARY WORKING PARTIES IN A SIEGE. THAT THE REGIMENTAL OFFICERS OF THE WORKING PARTIES SHOULD BE HELD STRICTLY RESPONSIBLE, FOR THE EXECUTION OF THE QUANTITY OF WORK ORDERED TO BE DONE, THAT MIXED WORKING PARTIES, COMPOSED OF MEN OF DIFFERENT CORPS, OUGHT NOT TO BE EMPLOYED.

The subject of this article is of such importance, that it appears proper to treat of it in some detail, although the general principle about to be developed, might have been inferred from some observations to the same effect, previously made.

It has already been implied, that the Engineers on duty should only be responsible for marking out the several works, for supplying materials and tools, and for making such arrangements and giving such directions, as will enable the working parties of the line to execute their tasks, to proper advantage. If the soldiers of the working parties do not exert themselves as they ought to do, let the Engineers make their representation to the general or field officers on duty in the trenches.

The regimental officers of the corps, which furnish the working parties, should be held solely and most strictly responsible, for the diligence and exertions of the men under their command. The Captains, Subaltern Officers and Serjeants, attached to each division of the working parties, should move about continually, to encourage the diligent, and reprove the idle: and the Field Officers in charge of several divisions should in like manner move about the whole line of workmen under their charge, to see that the men are diligent, and that the Officers and Serjeants† are doing their duty. These Field Officers should be held responsible for

* This rule has generally been followed in our sieges, in which an extra allowance of grog or wine has sometimes been ordered to each man of the military working parties, as a gratuity.

† It was before mentioned that Corporals, as rank and file, take their share of the work in the British Service.

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the diligence of the working parties under their command, by the General Officer or Officers, on duty in the trenches; and the latter should be responsible for the proper execution of the operations of each period of twenty-four hours, to the General Officer in command of the besieging army.

It is of the most vital importance to the success of a siege, that this system of responsibility, from the Regimental Officers of working parties to the General Officers on duty in the trenches, shall be established, and fully understood, and inflexibly adhered to; for which reason the commanding Engineer ought to apply to the Commander of the Forces, to issue a general order to this effect, previously to the opening of the trenches: for if this precaution be neglected, it is but too likely that many Officers of the working parties will remain perfectly inert, and leave every thing to the Engineers, who cannot be expected to keep the workmen diligent, when the latter see that their own Regimental Officers, who have more influence over them than any others, are either asleep, or grouped together in some corner, in conversation, in a state of apparent indifference to the progress of the work. Such an order is also necessary, to counteract a pernicious and unreasonable prejudice, which appeared to prevail amongst the Officers of some Regiments, of the Line, at the commencement of the late interesting wars with France, against being employed on working parties at all. Too much pains cannot be taken to prevent the recurrence of a feeling, so radically opposed to the success of all siege operations.

To carry this subject further, it may be considered of great importance in the execution of a parallel, and the same remark may generally apply to other works, of a siege; that the praise of diligence, and the disgrace of failure shall not be frittered away, by employing mixed working parties: but that one particular division of the army, shall have the whole of the operations of the first 24 hours, whether the men be relieved twice within that period, according to the old French system, or three times, according to the more usual system in our own service: and that each brigade and battalion of this division shall have its own distinct portion of the work, which no men of any other corps shall meddle with. Thus if the whole of the work directed to be done in the 24 hours should be well executed, the whole division generally will have the credit of it. If the whole should be badly executed or incomplete, the disgrace will attach to the division as a body; but if part only should fail, the dis-

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grace will attach to the particular Regiment, which, either neglected, or proved incompetent to its share of the duty.

In the construction of the first Batteries, which are usually commenced the second night, the same system should be followed, with a second Division of the besieging Army, each Battalion of which might have its own distinct Battery allotted to it; and by pursuing this system, both Regimental Officers and men would take a strong interest in siege operations, and would feel their own honour and reputation involved in them, which beneficial feeling by all accounts has hitherto scarcely ever prevailed amongst the Troops in general, in any of the Sieges carried on by the British Army. Indeed the operations of those Sieges, as recorded by Colonel Jones in his able and useful work, speak for themselves. When we find that in the Sieges of the Peninsula, a task of no more than 4 feet in length, 3 feet in depth, and 3½ feet in width, being very little more than 1½ cubic yard of excavation, was only executed by each individual of the Military Working Parties as their first night's work, which task we know by experience may be finished by an able-bodied man, with very moderate exertion, in three quarters of an hour, in easy soil, that requires little or no picking; and in one hour and a half, in the hardest and most difficult soil, that does not exactly come under the definition of rock; one cannot but feel mortified and ashamed that the exertions of the British Army, on such occasions, should have fallen so miserably short of their brilliant exploits in the Field.* It was not so in the Royal Navy, where Officers and Men equally disdained to skulk from useful labour as to shrink from danger; and where the watering of Nelson's Fleet on the Coast of Barbary, in an extraordinarily short space of time, just before he proceeded to the West Indies, was regarded with almost as much pride as the memorable victory of Trafalgar, that was gained not many months afterwards.

I attach so much importance to having the duty of working parties done by regular Divisions, Brigades, Battalions, and Companies, that I am confident, that any number of workmen, furnished according to this system, will do as much as twice their number of mixed working parties, each composed of Officers and Soldiers of different Regiments,

* Always, however, making an honourable exception in favour of the Working Parties furnished by His Majesty's Foot Guards, who did as much as Officers and Men could do, so that I really do not think that their exertions in making Batteries, &c. on service, have been exceeded even in our practice at this Establishment. I speak to this fact, not only from my own observation, but from that of Lieut.-Colonel Burgoyne, and other Brother Officers, of much greater experience than myself.



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furnished according to Roster: a system which in our service has been too often carried from the Garrison Guard-mounting* into the Camp of the besieging Army, and which in all cases, more or less, injures that organisation upon which discipline depends, and to a certain degree converts an Army into a mob.

### 9. OF THE NUMBER OF TIMES, THAT THE WORKING PARTIES, GUARDS OF THE TRENCHES, &c. OUGHT TO BE RELIEVED IN THE 24 HOURS.

It must be evident on a little reflection, that the marching backwards and forwards, between the trenches and their camp or cantonments, may occasion considerable fatigue to the troops of a besieging Army, besides occupying a good deal of time. Hence if the total number of reliefs or changes of men be limited to three or four at the utmost, which is usually the case, it follows, that the oftener they are relieved within the 24 hours, the more harassing it must be to those men, who might even, by increasing the number of times they were sent on duty within that period, be kept in almost constant movement, or preparation for movement, without due time for rest.

For this reason, the Guards of the Trenches, who, unless the enemy makes a sortie, are usually in a state of rest, with the exception of Pickets or Sentinels, or men employed as Sharpshooters, are not relieved oftener than once in 24 hours; and the same system is followed in relieving the Artillery, whose exertions are not generally of a very laborious nature, because the Ordnance, in a Siege, is not fired frequently and incessantly, as in battle.

The Working Parties, on the contrary, must necessarily be relieved oftener, for a man cannot work for more than 8 hours, without being exhausted; and if he be stimulated by taskwork, 4, 5, or 6 hours at the utmost, of actual exertion, will be quite sufficient.

On the other hand, it may be observed, that to bring a body of men into the Trenches, to execute any task involving

* In Garrisons, in which the duty is regulated by Roster, each Corps furnishing a daily detail, in proportion to its numbers, nothing is more common than to see a Guard composed of an Officer of one Regiment, Non-commissioned Officers of another, and Privates of two or three others. Hence no one Regiment or Corps can drill to advantage, for no Regiment is ever off guard in a body. Thus the discipline of all suffers: and if the duties of such mixed Guards involved any serious exertions or responsibility, it is my opinion, that the Service would be much more likely to suffer through neglect, than under the more salutary system of causing each Guard to be furnished by Officers, Non-commissioned Officers, and Privates, of one and the same Corps.

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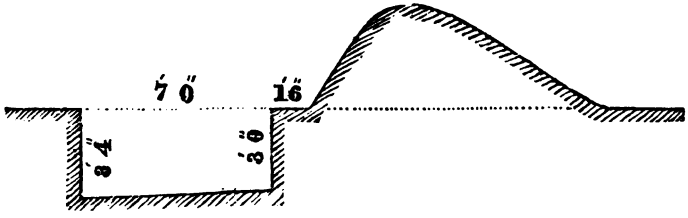
much less than 4 or 5 hours' labour, would really be trifling with the duties of a Siege. Now if the soil be of an easy description, requiring little or no picking, and if the whole Parallel be divided into three tasks or portions, such as were before described, each party might finish their respective tasks in less than 2 hours, which would be far too little.

In case therefore of very hard soil, it may be proper to divide the execution of a parallel into three tasks, but in soft soil, it would certainly be much better and less harassing to the troops, to divide the work into two tasks only, and consequently to have no more than two reliefs of workmen in 24 hours.

### 10. FIRST TASK, IN EXECUTING A FIRST PARALLEL BY TWO RELIEFS, IN EASY SOIL.

Being drawn up at the usual rate of 1 man to every 6 feet of trenchwork as before, each man must cut his portion of trench to the width of 7 feet from front to rear, making it 3 feet deep in front, and 3 feet 4 inches deep in rear, which amounts to 133 cubic feet, or very nearly 5 cubic yards of excavation.




### 11. SECOND TASK, IN EXECUTING A FIRST PARALLEL BY TWO RELIEFS, IN EASY SOIL.

The second Relief of men should be marched into the trenches at daylight, and should make the front step, and add 4 feet 6 inches to the width of the original trench, which will increase it to the clear width of 10 feet at bottom, over and above the base of the said step, and to the extreme depth of 3 feet 6 inches in rear; after which they must finish the trench, either with a reverse slope, having its base equal to its height, according to the profile before represented in the figure in page 60; or with steps in rear, according to the figure given in page 62.

When the Parallel is finished with a reverse slope, the task of the second Relief amounts to 129 cubic feet, or to rather more than 4⅓ cubic yards.



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When it is finished with reverse steps, the task of the second Relief amounts only to 108 cubic feet, or to 4 cubic yards.

In either case, after completing the excavation according to the profile prescribed, the second Relief of workmen must make a perfect finish of the parapet, and cut sesspools, &c. to secure the trench against the effects of rain, as before directed. Either will be an easy task, as the men have the whole day before them to execute, what would scarcely require more than from 2½ to 3 hours of active exertion at the utmost.

### 12. OF THE TOTAL NUMBER OF TROOPS NECESSARY IN A SIEGE, TO FURNISH MEN FOR EVERY OPERATION, IN REFERENCE TO THE NUMBER OF RELIEFS EMPLOYED IN EACH, IN THE 24 HOURS.

When Soldiers are employed in Military duties, in the Trenches or Batteries in a Siege, and are relieved only once in the 24 hours, three changes of men may suffice, and even when they are relieved twice in the 24 hours, the same proportion may regulate the total number of men necessary.

Thus for example, 6000 Infantry, and 1200 Artillery, might supply daily 2000 men for Guards of the Trenches, and 400 Gunners to man the Batteries in a Siege, as Troops employed in the former duty are only relieved once in the 24 hours, and the Artillery are seldom relieved oftener.

In respect to the Working Parties, as these would generally be relieved three times in the 24 hours, it is desirable that there should be four changes of men in all, by which means each relief would only be on duty once in 32 hours, which would allow ample time for rest, whilst this arrangement would prevent the same men from always coming on duty at night, which must necessarily be the case if there were only three changes of men to supply all the three Reliefs. If therefore the average number of workmen wanted for constant duty day and night, at the commencement of a Siege, should be estimated at 1200, it would require 4800 Infantry to supply this number in four Reliefs, three of which only should be employed within the space of 24 hours.

In estimating the number of Officers and Soldiers of the Engineer Department necessary for a Siege, the same rule should be observed, which applies to Working Parties of the Line. Hence the number of Reliefs would be the same for both, but it has been considered best to relieve the

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Engineers at intermediate periods, between the hours of relieving the workmen, in order that the former may get perfectly acquainted with every thing necessary, before the arrangement of the new Working Parties, which always occasions some difficulty, shall be thrown upon them. This was the system usually followed in the Spanish Peninsula.

It is evident, that over and above the number of men wanted for the daily operations of a Siege, a certain proportion would also be required, on account of casualties, to replace men killed or wounded by the enemy, or disabled by sickness, and also to furnish men for the necessary duties of drawing rations, cooking, and for various other little details, which always engross a much greater number of men than one would suppose, on a hasty view of the subject. But it is not my intention to enlarge further at present, on the mode of calculating the proper strength of a besieging Army. I shall therefore conclude this Article by observing, that such estimates should always be made in reference to the number of effective Rank and File, that can be spared daily for duty, exclusive of Soldiers necessarily employed in the various details before alluded to.

### 13. OF THE EXECUTION OF THE APPROACHES CONNECTED WITH THE FIRST PARALLEL.

The rules for tracing the Approaches connected with the first Parallel, and for commencing the work, have already been explained. It now only remains to treat of the execution.

The profile of an Approach so nearly resembles that of a Parallel, and the quantity of labour necessary for the completion of both differs so little, that, generally speaking, the same rules as to the number of Reliefs, and the proportioning of the task of each, may be followed in both cases.

The only difference in the Practice of this Establishment is, that we have made our Approaches generally a little deeper than our Parallels, and we have usually made the front steps and berm narrower, a banquette not being so essential, in the former, as in the latter. We have also usually made the parapets of our Approaches a little higher than those of our Parallels.

The reason is, that Approaches, being laid out obliquely, require more relief than a Parallel, in order to enable them to afford equal protection to the besiegers; for in the former, a man in the trench is covered by a distant point of the parapet, in an oblique direction, whereas, in the latter, he is

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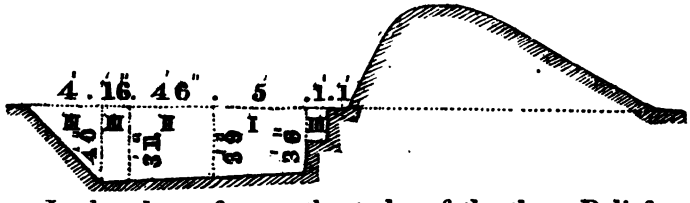
covered by that part of the parapet, which is near to, and perpendicularly in front of him.

The subjoined figure represents the profile usually adopted by us, in which the trench is 11 feet wide at bottom, 3 feet 6 inches deep in front, and 4 feet deep in rear. The berm and front step are only 1 foot wide. The latter instead of being formed with made earth, was cut out of the solid.




In the above figure, the tasks of the three Reliefs, as represented by the Roman numerals, I, II, and III, are as follows.

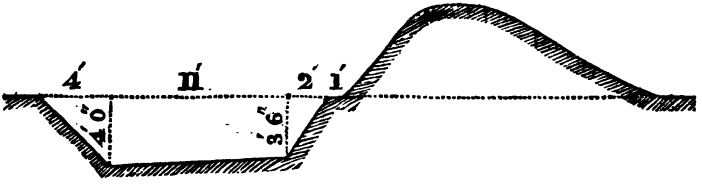
Each task being 6 feet in length, the first Relief are to cut a trench (I) 5 feet wide, 3 feet 6 inches deep in front, and 3 feet 9 inches deep in rear, which involves 108¾ cubic feet, or about 4 cubic yards of excavation.

The second Relief are to cut the Trench 4 feet 6 inches wider, and 2 inches deeper in rear, which involves a task (II) of 99 cubic feet, being equal to 3⅔ cubic yards of excavation.

The third Relief are to cut the Trench 1 foot 6 inches wider, and 1 inch deeper, which increases the total width of the Approach to 11 feet. They will then cut the reverse slope, giving to it a base of 4 feet, which is equal to the extreme depth of the trench in rear. This being done, they will cut the front step, making it 1 foot wide, and 1 foot 9 inches high, or one half of the depth of the Trench in front. These three portions (each marked III, III, III,) amount in all to 85⅜ cubic feet, being nearly 3⅛ cubic yards of excavation.

The whole of these tasks added together, involve 293⅛ cubic feet, or very nearly 10⅝ cubic yards of excavation.

Sometimes an Approach is made with slopes only, without having any steps in front, as shown in the annexed figure, which arrangement, however, can make little or no difference, in the quantity of labour, or in the tasking of the men.

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14. THAT ALL TRENCHES, OR DITCHES, SHOULD BE COMMENCED BY VERTICAL EXCAVATIONS, FINISHING THE SLOPES LAST.

Whenever an Approach is formed with slopes in front and rear, as represented in the foregoing figure, the body of the Trench is completed first, and both the slopes are cut afterwards. And let it be understood, that this is a rule, which we have invariably followed, not only in forming the Trenches of Parallels and Approaches, but in respect to the Ditches of Elevated Batteries, and other excavations generally, in Field Fortification. We always commenced with vertical cuts of a rectangular section, until the great mass of excavation was finished, doing the slopes last of all. In executing these, the crest of each slope should first be marked out on the ground, after which small sections should be cut here and there, according to the proper form of the finished profile. Finally the intermediate earth should be cut away, between these small sections, which answer the same purpose of insuring regularity in an excavation, that wooden profiles erected at intervals do, in the formation of a parapet.

If, on the contrary, the slopes be commenced from the first, without these precautions, the men will either lose time in attempting accuracy; or will cut them at random, and thereby either disfigure the work, or injure its stability.

## SECTION IX.

### OF THE EXECUTION OF THE SECOND PARALLEL, AND THE APPROACHES CONNECTED WITH IT.

1. RULES FOR EXECUTING A SECOND PARALLEL COMMENCED BY THE FLYING SAP.

The method of arranging the workmen with their tools, behind the line of gabions, so that the space covered shall be at the rate of 2 gabions, or about 4 feet per man, has already been explained. In this order the men are rather more crowded than one could desire, but the use of gabions, the size of which is necessarily limited, leaves no alternative.

When the order is given to commence work, every man will begin digging in rear of his own two gabions, which he will fill with all expedition, striking the sides of the gabions from time to time with his shovel, and afterwards patting the earth at top, to shake it down and make it compact, before he

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throws any of it over. When filled, which may be done by good workmen in from 5 to 10 minutes, the line of gabions will be musket proof every where, excepting at the intervals between adjacent ones. The Engineer Officers superintending, and the Sappers attached to Divisions, will take care to instruct the men to force their gabions forward at top, whilst the work is in progress, in order to give them a slope of about one fourth of their height, which is necessary to their stability, and which may be judged of, with sufficient accuracy, by the eye. This arrangement may be aided by introducing sods under the back of each gabion. The usual berm of 18 inches, must be left behind the line of gabions.

The Parapet of a second Parallel may be crowned with one or more rows of fascines laid over the gabions, with which it is reveted interiorly. In other respects, it does not differ from that of a first Parallel, and the Trenches of both are exactly alike.

When fascines are used to crown the gabions in a second Parallel, which arrangement however can scarcely be necessary under ordinary circumstances, the second and third Reliefs of men ought to take them out with them, each man carrying a 6 feet fascine, and 2 or 3 pickets. If more fascines and pickets should be required, at this period, and generally speaking on any other occasion, when the regular working parties cannot carry a sufficient quantity of materials for their own use, the Guards of the Trenches may be ordered to call at the Engineers' Depôt, for the purpose of receiving materials, which they will deposit on the reverse of the Trenches, in such situations as shall be deemed most convenient.

In difficult soil, the second Parallel may be finished by three reliefs of men, in easy soil by two: and in either case, their respective tasks of excavation, as seen in profile, should be the same as in a first Parallel; but as the workmen are less extended in the second Parallel, the actual quantity of excavation to be executed by the men of each relief, will only be two thirds of the task allotted to the corresponding Reliefs in the first Parallel. Although 4 feet per man is rather too crowded on commencing, as was before observed, this inconvenience is less felt, after the Trench attains the width of 5 or 6 feet; so that on the whole, it it better, having begun in this order through necessity, to persevere in the same with the succeeding Reliefs, until the Parallel shall be finished; for all changes of arrangement during the progress of a work give additional trouble, and may cause confusion and loss of time.

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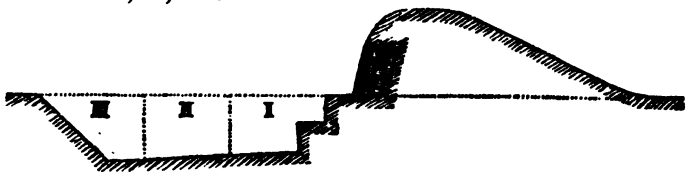
The annexed figure is the section of a second Parallel, finished with gabions only, not crowned by fascines, in which the tasks of the three Reliefs are marked by the Roman numerals I, II, III.




The task of the first Relief includes also the excavation of the space, now occupied by the front step, which is supposed to have been added afterwards by the second Relief. The clear width at the sole of the Trench is supposed to be 10 feet, being the same as in the first Parallel, with which it likewise agrees in all its other dimensions, as was before stated.

2. STATEMENT, BOTH IN CUBIC FEET, AND IN CUBIC YARDS, OF THE QUANTITY OF EXCAVATION IN A FIRST PARALLEL, AT 6 RUNNING FEET OF TRENCH-WORK PER MAN, AS COMPARED WITH THAT OF A SECOND PARALLEL COMMENCED BY THE FLYING SAP, AT 4 RUNNING FEET ONLY PER MAN, ALL OTHER PARTICULARS BEING THE SAME IN BOTH. *(Compare the foregoing figure with that in page* 60.*)*

| COMPARATIVE EXCAVATION. | 1st Parallel. | | 2d Parallel. | |
|---|---|---|---|---|
| | *Cubic Feet.* | *Cubic Yds.* | *Cubic Feet.* | *Cubic Yds.* |
| 1st Task (I) 5 feet wide, 3 feet deep in front, 3 feet 3 inches deep in rear ..... | $93\frac{3}{4}$ | $3\frac{1}{3}$ | $62\frac{1}{2}$ | $2\frac{1}{3}$ |
| 2d Task (II) 4 feet 6 inches wider, 3 feet 3 inches deep in front, 3 feet 5 inches deep in rear .... | 90 | $3\frac{1}{3}$ | 60 | $2\frac{2}{9}$ |
| 3d Task (III) 2 feet wider at bottom, which completes the sole of the Trench, making it 3 feet 6 inches deep in rear, and a reverse slope, having a base of 3 feet 6 inches, equal to its height..... | $78\frac{1}{4}$ | $2\frac{8}{9}$ | $52\frac{1}{6}$ | $1\frac{8}{9}$ |
| Total..... | 262 | $9\frac{2}{3}$ | $174\frac{2}{3}$ | $6\frac{4}{9}$ |

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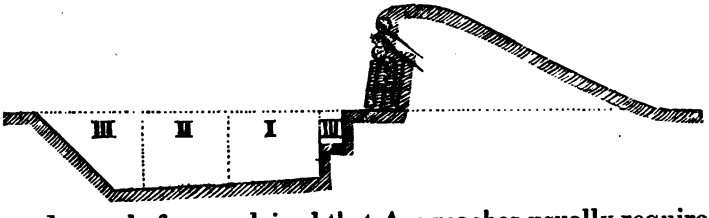
### 3. RULES FOR EXECUTING THE APPROACHES CONNECTED WITH THE SECOND PARALLEL, AND COMMENCED BY THE FLYING SAP.

These also differ from the first Approaches, only in having their Parapets reveted with gabions, or with gabions and fascines, the profile of the Trenches of both being exactly alike.

In the execution, no further difference occurs, than what must necessarily arise from the use of gabions, the tasks of the several Reliefs of men employed being also alike in profile, and proportional to each other, in the ratio of 2 to 3, in consequence of the men, who work by the flying sap, being drawn up at intervals of 4 feet apart, whilst those who commence without gabions, have each a task of 6 feet.

The subjoined figure is the Section to an Approach of this description, commenced by the flying sap, and having its gabions crowned by 3 courses of fascines, which should be laid at the same slope of one fourth, which was before prescribed in placing the gabions.

These fascines must be secured by pickets driven through them, obliquely downwards into the earth, at an angle of about 45°. There should be two such pickets to a 6 feet fascine.




It was before explained that Approaches usually require more relief than a Parallel: and for this reason it may sometimes be expedient, to crown the Parapets of Approaches commenced by the flying sap, with several courses of fascines, as shewn in the above figure; whereas this precaution might be entirely dispensed with, in a second Parallel, situated at the same distance from a Fortress of equal command.

The want of cover in the Trenches of Approaches is more felt at the angles of the zigzags, than any where else: and therefore it may sometimes be expedient, even in the Approaches in rear of the first Parallel, which are generally left unreveted, to revete their Parapets, for about 10 or 12 feet, at each angle of the zigzags only. It may also be proper for the same reason, to cover out those angles by raising not only their own Parapets, but also certain portions of the Parapets of the Trenches in front of them, and at some

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distance from them, one or more feet higher than the general level of the adjoining Parapets.

Portions of the Parapets thus raised, although for a different purpose, partake of the nature of Trench Cavaliers, so far as the construction alone is concerned: and therefore when more than usual height is required, it might be preferable to use a couple of tiers of gabions, with one intermediate row of fascines, instead of gaining the whole height necessary, by crowning one course of gabions entirely with fascines, in the manner represented in the foregoing figure. But as well reveted Parapets, which are always essential in Gun Batteries and Trench Cavaliers, are only required occasionally in Approaches, I shall not enlarge further upon the construction of such revetments at present.

When small portions only of a set of Approaches are to be reveted, or when small portions only of the Parapets of the Trenches are to be raised; it is better to employ extra men for the purpose of executing such details, than to make them a part of the task of any of the regular working parties.

4. STATEMENT, BOTH IN CUBIC FEET, AND IN CUBIC YARDS, OF THE QUANTITY OF EXCAVATION IN THE FIRST APPROACHES, AT 6 RUNNING FEET OF TRENCH WORK PER MAN, AS COMPARED WITH THE MORE ADVANCED APPROACHES AFTERWARDS COMMENCED BY THE FLYING SAP, AT 4 RUNNING FEET OF TRENCH WORK PER MAN. *(Compare the foregoing figure with the first figure in page 70.)*

| COMPARATIVE EXCAVATION. | *1st Approaches.* | | *Advanced Aps.* | |
|---|---|---|---|---|
| | *Cubic Feet.* | *Cubic Yds.* | *Cubic Feet.* | *Cubic Yds.* |
| 1st Task, 5 feet wide, 3 feet 6 inches deep in front, and 3 feet 9 inches deep in rear..... | 108$\frac{3}{4}$ | 4 | 72$\frac{1}{2}$ | 2$\frac{2}{3}$ |
| 2d Task, 4 feet 6 inches wider, 3 feet 9 inches deep in front, and 3 feet 11 inches deep in rear.... | 99 | 3$\frac{2}{3}$ | 66 | 2$\frac{4}{9}$ |
| 3d Task, 1 foot 6 inches wider at bottom, and 4 feet extreme depth, besides a reverse slope of 4 feet base, and a front step of 1 foot wide, and 1 foot 9 inches deep.. | 85$\frac{3}{8}$ | 3$\frac{1}{6}$ | 56$\frac{11}{12}$ | 2$\frac{1}{9}$ |
| Total..... | 293$\frac{1}{8}$ | 10$\frac{5}{6}$ | 195$\frac{5}{12}$ | 7$\frac{2}{9}$ |

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### 5. OF FLANKING BOYAUS, OR SUCH PORTIONS OF THE APPROACHES, IN A SIEGE, AS PARTAKE ALSO OF THE NATURE OF PARALLELS.

When a set of Approaches are on the extreme right, or on the extreme left of the Trenches, in a Siege, those branches of them, which have their Parapets facing outwards, are termed flanking Boyaus, and may be made to answer the double purpose of acting also as Places of Arms, or Parallels for containing the Troops destined to repulse the sorties made by the besieged, if such sorties should be attempted, as is most frequently the case, on the flanks of the Trenches.

Thus, for example, if we suppose the first and second Parallels, and the Approaches from the rear to the second Parallel in a Siege to be finished, and that an enemy makes a sortie at this period, it will be evident, that if he advances in front, the Troops in the Parallels, will oppose him by a direct fire: but if he should attempt to penetrate in rear of the second or first Parallel by either flank, Troops placed in flanking Boyaus, will be more conveniently situated than those in either of the two Parallels for defeating this object.

Flanking Boyaus, therefore, should never be finished with a front slope, as shown in figure 2, page 70, nor with narrow steps; but with broad steps and a banquette, like a parallel. In other respects they need not differ from common Approaches.

END OF PART I.

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*N. B. All the Wood Engravings were executed by Lance Corporals William Reid and John West, and Privates John Vance and John Henderson, excepting the Emblem in the title page, which was by Mr. Austin, a London Artist.*

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# RULES,

CHIEFLY DEDUCED FROM EXPERIMENT,

*FOR CONDUCTING THE*

# PRACTICAL OPERATIONS OF A SIEGE.

BY

*C. W. PASLEY, COLONEL R.E., C.B., F.R.S., &c.*

## PART, II.

CONTAINING
AN ESSAY ON THE CONSTRUCTION OF
BATTERIES IN THE FIELD.

PRINTED
FOR THE USE OF THE ESTABLISHMENT FOR FIELD INSTRUCTION.
CHATHAM.

1832

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# MEMORANDA.

When this subject happened to come under discussion, some years ago, the Inspector General of Fortifications expressed his desire to Colonel Pasley, which was equivalent to an order that the Books or Papers printed or lithographed for the use of the Establishment for Field Instruction, and relating to the particular duties thereof, should not be published, or used as Materials for publication; excepting of course such parts of their contents, as are common to all Elementary Books on Fortification and the Attack of Places. Let it therefore be understood, as the express condition under which these works are issued, that the Officers or Gentlemen in the public Service, who may be allowed to have them, shall stand pledged to use due discretion in this respect, and to abstain from using them for any other purpose, than the Military Service of this Country, for which exclusively they were intended.

As these works are not published for general sale, being only issued to Officers or Gentlemen belonging to or connected with the King's or Hon. East India Company's service who may apply for them, and consequently as the number of copies will be limited; it may probably be necessary to put a higher price on them, than printed books of the same size and quality are usually sold for: but whatever profit, if any, may arise, after covering the expense of paper, printing, &c., will be appropriated to the benefit of the Establishment, according to the practice hitherto followed, in respect to the former lithographed works on the same subjects.*

* These Memoranda are reprinted from the Preface to Part I, for the information and guidance of those, who may obtain this Second Part, without the former.

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# PREFACE

## TO THE SECOND PART OF THE

## PRACTICAL OPERATIONS OF A SIEGE,

## &c.

---

Having observed, or rather felt from my own experience in early life, that the degree of knowledge of Elementary Fortification and of the Attack of Places, which is acquired at any Military Academy, or College, is of a general nature, forming certainly a very useful ground work for after study, but nothing more; and afterwards, when I had the opportunity of gaining some experience, having further observed, that amongst the multitude of Authors on this subject, there was none, who treated the Operations of a Siege, in so clear, and satisfactory a manner as appeared to me to be desirable; I was induced some years ago to commence an Elementary Treatise on the Attack of Fortresses, of which a few copies only were lithographed, and issued to those junior Officers of his Majesty's and of the Hon. East India Companys' Engineers who desired it.

Although I have been assured that this Treatise gave general satisfaction, I never finished it, because it afterwards occurred to me, that the object I had in view might be more effectually attained by a different arrangement.

In that work I had imitated, to a certain degree, the usual routine hitherto followed by former Elementary

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writers on the Attack of Fortresses, who interrupt at every step, the general rules and principles, according to which a Siege ought to be conducted, by intermixing therewith the most minute details, such as the making of a fascine or a gabion, the arrangement of workmen, the detailed profile of a parallel, or approach, the dimensions of an embrasure, a platform, or of a mine frame, &c. &c.; and who incessantly fly backwards and forwards from one to the other, with such frequency of alternation, that the mind is distracted, and is far from acquiring clear notions on this important subject, which is not unfrequently still farther embroiled by Algebra and Fluxions.

The improvement, that afterwards occurred to me, in respect to the study of the Attack of Fortified Places was simply this; to treat every operation, which forms part of a regular Siege, or an indispensable preliminary thereto, as a Study in itself, unconnected with any of the other multifarious matters, involved in the same great question; and in thus treating each operation independently, to pursue it into all its details.

On this principle, I wrote the little Treatises on each several Practical Operation of a Siege, which were originally lithographed separately, for the use of this Establishment, but which it is now proposed to embody, in the more commodious form of a connected work, of which the following Pages form the Second Part.

When the young Engineer Officer shall have made himself master of all the Practical Operations of a Siege in detail, he ought to peruse with attention the historical records or journals of the most celebrated modern Sieges, which if analyzed as a Study, cannot fail to be highly improving. After this is the time, but not before, for him to study the most celebrated Continental writers on Fortification and the Attack of Places: for he will then be able to profit by their general views in respect to the higher

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branches of the art, without being drawn by their authority into those errors of detail, in respect to Practical Operations, in which their works too often abound.

Without wishing to depreciate the writers alluded to, I may be permitted to observe, that both in France and in Germany, where military knowledge is much more generally diffused, than it has hitherto been in this Country, a number of ingenious Military Officers or Professors have occupied their minds, with the Studies in question, who appear to me either not to have had the means of trying experiments, or to have disdained them: and therefore whilst their general ideas may be excellent, they fall short in the practical part, and are so far liable to mislead inexperienced readers, that they seldom or never distinguish between that which has, and that which has not, been actually tried. This is an omission so embarrassing to a Student, as I have found by experience, that I have taken the utmost care to avoid it, in every thing I have written. Whatever is laid down as a rule, has been deduced from numerous experiments: that which has not been fairly and fully tried, is stated as a mere suggestion or untried idea. The former may be relied upon with confidence: the latter may or may not succeed; and in the Practice of this Establishment we have so often found the most promising measures fail, that I consider every thing untried as a matter of doubt, however plausible. And yet an Engineer must necessarily hazard many new and untried measures in war: but those should be suggested by circumstances occurring at the moment, in which his own judgement is more likely to guide him right, than the authority of speculative writers however highly talented.

At the same time, that the Foreign Authors now alluded to recommend untried or new expedients with that confidence, which ought only to attach to things tried and known, they generally over-rate the means both of men and materials, that ought to be employed by Engineers in the Field.

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For example, Bousmard in his valuable and celebrated Elementary Work on Fortification, and on the Attack of Places, talks seriously of reveting the whole of the first parallel in a Siege with Fascines. It is difficult to conceive a more useless waste of a useful material.

The same Author, and after him Gai de Vernon, in another deservedly esteemed Elementary Work, recommend the passage of the wet ditch of a Fortress, in which there is a current, to be effected by means of a floating bridge of 6 feet fascines to be put together in the water, moored by means of anchors, and consolidated by baulks and pickets. On the side exposed to the enemy's fire, it is to be protected by a massy epaulment or flanking parapet of fascines. I must confess that a floating bridge of this description appears to me to be impracticable: for independent of the difficulties of working in a current with such materials, I conceive that the weight of the epaulment would be sure to capsize the bridge, before it could be completed to the Profile described by Bousmard. This will appear evident by inspecting the 12th Plate of that Authors' Essai General, Figs. 1 and 4.

Rouvroy a German writer on Battery building, the first I believe, who dedicated a professed Treatise exclusively to this important subject, which was published at Leipsic in 1809,* revets not only the inside, but the outside of his Parapet and Epaulments, and even the ends of the latter with fascines; and for an elevated battery of 6 guns and 2 mortars, having one substantial engaged Traverse, and 2 Epaulments, he recommends employing no less than 668 workmen for the first night, according to the following very curious detail.

* Entitled 'Handbuch des Batteriebaues oder die Anlegung und Erbauung der Batterien, beim Angriff fester Plätze.' The Author was then a First Lieutenant in the Royal Corps of Saxon Field Artillery, and Battery Master at the Artillery School,

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| | Men. |
|---|---|
| Diggers in the ditch of the Battery in 3 rows | 252 |
| Shovellers and Rammers on the berm and parapet in 2 rows | 138 |
| Builders with Fascines | 39 |
| Assistants to the Builders | 52 |
| To dig, fill, and carry earth from the rear in baskets, if necessary | 162 |
| To cut two Boyaus of communication from a Parallel in rear | 25 |
| Total | 668 |

At daylight, he employs a second party of two hundred and twelve men, according to the following arrangement,

| | Men. |
|---|---|
| Sinking the interior of the Mortar part of the Battery | 24 |
| At the Traverse | 12 |
| Digging the body of the Powder Magazine | 10 |
| Entrances of the same | 15 |
| Four ramps or communications with the Parallel in rear | 18 |
| Fascine Builders as by night | 39 |
| Builder's Assistants | 52 |
| Carpenters to prepare Magazine timbers and Platforms | 14 |
| Carpenter's Assistants | 28 |
| Total | 212 |

The second night he returns to the first arrangement of 668 men; and at daylight, his Battery is supposed to be finished.

It is to be observed, that in addition to the fascine work before mentioned, he forms banquettes of two steps, reveted

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each with two courses of fascines, throughout the whole extent of his Parapet and Epaulment, excepting only in front of each gun Platform, where there is a break in the line. Moreover his Mortar Battery has a total relief of 9 feet, as the parapet is elevated 7 feet above the natural ground level, whilst the interior of the battery is sunk 2 feet below it.

How very curious all this is! What a prodigious waste of means, and misapplication of labour! At this rate 5000 or 6000 men might be required as working Parties to commence the first Batteries, in the Siege of a Fortress of any importance; and the reliefs necessary to carry on these Batteries simultaneously, might swell the number of such workmen to 20,000 men.

Another Book, written exclusively on the subject of Batteries, and published in Paris, in 1826, by Field Marshal Ravichio de Petersdorf, and Colonel A. P. F. Nancy, is full of ideas almost equally crude. They explain in treating of the details of construction, and arrangement; first the method of the French school, and secondly that of the German, or rather Austrian school.

In respect to the employment of the men, the French system is much the more rational. Although they have workmen in considerable excess, it is not to that degree, that would create inextricable confusion. Indeed it is right for me to acknowledge, that before we had an opportunity of acquiring any practical knowledge of this subject by experiment, I derived all my notions of making Batteries from a French book of deserved reputation, entitled the " Aide Mémoire, a l'usage des Officiers d'Artillerie de France " which contains an elaborate article on that subject. The more modern French authors, whom I have just quoted, follow the example of the Aide Mémoire in reveting not only the inside but the outside of their Batteries, as well as the extremities of the parapet, which generally seem to be made without epaulments, being set off abruptly with half

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merlons rather longer than usual.* These authors have so far improved upon the Aide Mémoire, that instead of confining themselves exclusively to fascine revetments, which are the only ones noticed in that work, they treat of all other materials applicable to the purpose, such as sand bags, gabions, &c.; and I have reason to believe that the latter have generally been used by the French, in their Batteries made for practice, in preference to long fascines. These authors also treat of field powder magazines covered according to the British system, instead of mere holes in the ground, which seems to have been the original French fashion.

With the exception of the book before quoted, not having been able to procure any other German work on this subject, I must refer to the two French authors above mentioned for a description of the German system of Battery building, which is said to be taken from the most modern German writers, and which forms the most curious part of their treatise. According to this system, if correctly stated, when the Germans propose to form a battery in a parallel, which is said to be their usual custom, instead of adding more earth in front of the parapet of the parallel to complete that of the battery to the proper thickness, they add earth in rear of the parapet; and thus they actually fill up a great part of the trench of the parallel, whilst they take from the reverse of it. And it is stated, that they even apply the same system to the construction of elevated batteries in a parallel, in making which they raise the greater part of the parapet on the site of the trench, so that the three feet originally cut away are entirely filled up again; and thus it becomes necessary to construct a parapet of 10 feet in height, reveted with fascines from the bottom upwards, which is afterward reduced to 7 feet by the above singular process. The building of

* This curious arrangement explains the reason, why the French apply the term *Coffer* to the *Solid* or lower part of the Parapet of an elevated Gun Battery. In a battery thus constructed, it is a mass of earth literally enclosed in a case or coffer of fascine work.

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Batteries on this principle, may justly be compared to Penelope's web: and as the French authors who record this absurd construction scarcely make a comment upon it, I must again repeat that the perusal of such works is more likely to perplex and mislead, than to benefit an inexperienced reader.

In respect to the superintendence of the work, according to the French system, if correctly reported by the above authors, one cannot help being struck by the proposition, of having no less than 2 Officers to direct, and 2 of Infantry to assist, in the construction of a three gun Battery: and for a battery of 6 guns, they recommend employing 3 Officers to direct, and 6 of Infantry to assist.

In the British Service, as now constituted, with the Non-Commissioned Officers and Soldiers of the Department trained to those details, one Engineer Officer would suffice to direct the construction of the largest Battery, or even of more than one; whilst the number of Infantry Officers attached to the working parties, who ought all to belong to the same Battalions which furnish them, would be regulated as a matter of discipline, without any reference to the number of pieces of ordnance for which the battery was to be prepared.

In the German School, according to the report of the same French Authors before quoted, an elevated Battery of 10 guns, requires 2 Officers to direct, assisted by 5 Officers of Infantry, with 16 Non-Commissioned Officers, and 376 Workmen, of whom 10 are Carpenters. As they state, that the working parties are only relieved once in 24 hours, if one half of these men rest whilst the others work, the above detail is not greatly in excess. If they all do what they can, working at the same time, it is by far too many men to employ; and in either case, why fill the trenches with idlers or superfluous hands, which must increase the number of casualties by the enemy's fire, without adequate advantage?

I think it probable, however, that when batteries have actually been constructed in either of the two above men-

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tioned services, fewer men may have been employed, and fewer materials wasted. As there must be many other duties to occupy the Soldiers attached to such Institutions, it is probable both at the French and Austrian Schools of Instruction, that a small number of men only may work at the same time in the construction of Batteries made for show, and allowed to remain as permanent specimens of fine workmanship. And on actual Service, necessity must generally have compelled besieging armies not to lavish their means. Still the principle of prodigal expenditure, by which the French and German constructions appear to be regulated, must have a prejudicial effect, by teaching Officers to consider that proper, which is in reality superfluous, as a consequence of which, men of weak minds might be induced to give up an easy and practicable enterprise as entirely hopeless, if they had not all the surplus means erroneously recommended in the Military Schools, at which they had been educated. Of this lavish and unnecessary expenditure of materials, the very curious construction of the French and Spanish Batteries against Gibraltar in 1782, may be considered a proof. Indeed it was worse than useless for it caused those Batteries to be destroyed by fire, in a sortie of the Garrison,* whereas batteries constructed on a more rational system would have been incombustible.

With us at Chatham not only the practice, but the principle is different. Limited from the first as to brushwood,

* Since the above was written, I have seen another French work on Batteries, published by Captain J. N. Lamy of the Royal French Artillery in 1827, who is the first Foreign Author I have met with, that does not recommend an excess of materials. But he has rendered his practical part unintelligible by complex and useless Algebraical formulæ, and intricate Tables. In one or two parts of his work, he has introduced some very crude ideas. For example, he recommends making blinded breaching batteries, to be covered not only with strong timbers, but with 6 feet of earth. And he is not contented with the proportion of workmen for common gun and mortar Batteries stated in the Aide Mémoire, although even that proportion is in considerable excess.

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we very soon found the necessity of economising fascines and gabions, and afterwards we applied the same principle to other materials: and when by degrees we got rid of the trammels imposed upon us, by the French writers, who were our only guides at first, and to whom I must again acknowledge my obligations; we also economised labour, by not employing any superfluous men in our operations. Accordingly, I do not scruple to say, that by using less than one half of the quantity of materials, and about one fourth of the number of men, we could complete an elevated Battery for eight guns and two mortars in the same time as Rouvroy with his 668 Saxons, and with much greater ease, because with infinitely less confusion. Indeed we once tried for the sake of experiment, what effect would be produced by employing the greatest number of men that could possibly work together, namely 220, in making an elevated Battery for two guns, with two epaulments. The earth for the parapet was of course obtained, both from the front and rear, but without extending the men beyond the flanks of the Battery, which would not have been a fair experiment. Such a mass of men working and moving about in so small a space resembled a swarm of ants, and it almost dazzled the eyes to behold them; but although they were all robust young men and as diligent as could reasonably be expected, and relieved every four hours, to our great surprise, the work was not finished much quicker than such batteries had formerly been done, by about one third of the number of men.* But this was an experiment tried from mere curiosity, for it is obvious, that no besieging Army, when about to construct their first Batteries, could ever afford workmen in so large a proportion, considering that whatever number may be employed at once, there must be two or rather three times as many more in reserve, to afford

* This experimental Battery was made in November, 1824. Two hundred men of each Relief of the working parties employed, were Recruits in the Service of the Hon. East India Company.

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the necessary reliefs, in order that the work may go on night and day. Other experiments of a more conclusive nature, were therefore tried, in 1826, when for the first time, we began to suspect that the old system of battery building was founded in error. That season we employed various numbers and arrangements of workmen, in constructing several successive one gun batteries, both elevated, sunken, and half sunken, carefully noting the time occupied in the completion of each, and other particulars. These experiments led to the result, that 10 or 12 men per gun or mortar, proved capable of executing, apparently with equal ease to themselves, and in the same time, the same quantity of work for which we had always told off from 20 to 24 men in former years. The last mentioned proportion of workmen, or even more had usually been demanded in the sieges in the Spanish Peninsula, for the Officers there also very naturally followed the rules laid down by the French writers, who were in those days our only guides both in the Theory, and in the practice of Military Engineering. But I believe that in Canada on one or two occasions, in our late war against the Americans, the proportions recommended by those writers were considerably exceeded, as I have heard, that a Commanding Engineer demanded working parties for making his batteries, on a scale much greater even than the estimates of Rouvroy which I have already commented upon.

The discovery, for it literally deserves the name, resulting from our experiments of 1826, will probably be of great benefit to the service hereafter; for no doubt the new practice of battery building deduced from these experiments, will be adopted in the event of sieges being undertaken by a British army in some future war, and will lead to a great saving either of time or of labour; or more strictly speaking it will prevent the misapplication of labour in the construction of batteries to such a degree, as will diminish by nearly one half the fatigue and exertion of the working parties employed in this duty. It is almost need-

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less to suggest, that it may be expected also to diminish the number of casualties in the same proportion.

I shall conclude by observing, that after the first sheets of this second part of the Practical Operations of a Siege were sent to press, and whilst the printing of the whole was in progress, new views developed themselves from time to time, and new experiments were continually tried, which led to improvements not originally contemplated. Under such circumstances, this volume has swelled to a larger size than I expected, and I regret that it is not in my power to remodel it, and condense it into a much smaller space, which I might do by writing it over again, but unfortunately not without sacrificing the whole of this edition.

After the third and fourth parts of the present work, and the treatise on Military Bridges before announced shall be finished, I have it in view to draw up a more compendious work containing the substance of the above, with other useful professional information relating to the duties of an Engineer Officer in the field, classed in alphabetical order, on the principle of Adye's Pocket Gunner.

*Chatham, the 16th May,* 1832.

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# RULES, &c.

FOR CONDUCTING THE

## PRACTICAL OPERATIONS OF A SIEGE.

# PART II.

## SECTION I.

### THE SEVERAL KINDS OF BATTERIES DEFINED. THE COMPONENT PARTS OF AN ELEVATED GUN BATTERY EXPLAINED IN DETAIL.

#### 1. THE SEVERAL KINDS OF BATTERIES DEFINED.

In reference to their construction, Batteries are either Cavalier Batteries, Elevated Batteries, Sunken Batteries, or Half-sunken Batteries.

*First—Cavalier Batteries*, in which the terreplein or interior of the Battery is raised some feet above the natural ground level, are seldom or never used, because the little additional command thus gained does not compensate the great extra labour of this construction. In no case, therefore do I recommend it. If your distant Batteries cannot see the enemy's works sufficiently, sap close up to them.

*Secondly—Elevated Batteries* are those in which the interior of the Battery is on the natural ground level, whilst the whole of the parapet is raised above it.

*Thirdly—Sunken Batteries* are those in which the interior of the Battery is excavated to such a depth, that about two fifth parts of the extreme height of the parapet are sunk below the natural level of the ground.

*Fourthly—Half sunken Batteries* are those in which the interior of the Battery is excavated to such a depth, that



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about one fourth part of the extreme height of the parapet is sunk below the natural level of the ground.

Hence in sunken gun batteries, the whole sill of the embrasure is sunk, but in half sunken gun batteries it is only about half sunk, below that level.

In reference to their direction, Batteries may either be,

*First—Direct Batteries*, that is such as have their line of fire perpendicular to the enemy's work, against which they are to act or nearly so. This is the best arrangement for laying out *Breaching Batteries*, and also *Counter Batteries*, the latter of which are intended to silence an enemy's guns, by a direct fire with full charges of powder.

*Secondly—Enfilading Batteries*, which rake or scour a whole face or line of an Enemy's Fortress in flank.

*Thirdly—Oblique Batteries*, whose direction is intermediate between these two.

*Fourthly—Reverse Batteries*, which take an enemy's work in rear, either directly or obliquely.

In reference to the manner in which shot or shells may be thrown from them, the fire of Batteries is said to be,

*First—A Horizontal Fire*,* as that of shot, thrown direct from a gun at moderate ranges, and with full charges of powder.

*Secondly—A Vertical Fire*,* as that of shells thrown from a mortar at great elevations.

*Thirdly—A Ricochet Fire*, that is an enfilading fire of shot thrown from a Gun, or of shells from a Howitzer, with small charges and at moderate elevations.

*Fourthly—A Pitching Fire*, that is a fire of shot or shells thrown with small charges and moderate elevations, like the last, but which attacks the work directly in front, instead of enfilading it. This kind of fire is a novelty in the practice of Artillery, having been used for the first time against Carnot's wall, at Woolwich, in 1821.

It appeared proper to notice these particulars, because upon the peculiar mode of firing, proposed to be adopted, it depends, first, whether a Battery is to have embrasures, or not; and secondly what the form of embrasure, if any, shall be.

* Neither of these terms is good, for shot fired according to the former mode need not move horizontally, and shells from a mortar do not fall vertically, but both terms having been generally used in works of reputation, they cannot well be set aside.

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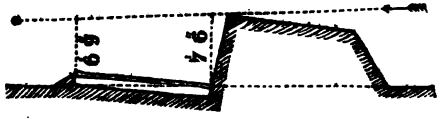
## 2. GENERAL REMARKS ON THE CIRCUMSTANCES, BY WHICH THE PROFILE OF SIEGE BATTERIES SHOULD BE REGULATED.

In considering the general profile proper for a siege Battery, the principal dimensions depend chiefly on the relative command of the Enemy's works, over the spot, on which the Battery is to be constructed. In determining those dimensions, we will therefore first suppose the Fortress, that is to be attacked to be situated on an extensive plain, in which case its command must necessarily be moderate; for the line of fire of the Guns mounted on the ramparts cannot have a dip of much more than one foot in a hundred, as directed against the first Batteries of a besieging army, if placed at the usual distance in front of the first parallel. This supposition will be adhered to, until all the details of Battery Building shall have been carefully discussed, as applied to the construction of elevated Batteries, after which the nature of sunken and half sunken Batteries, to which the same general rules apply, with little variation, will next be explained. But the consideration of those varieties in the Profile or Outline of Siege Batteries, which it may be proper to adopt on irregular ground, will be reserved until the conclusion of this Essay.

## 3. OF THE PROFILE PROPER FOR THE PARAPET OF AN ELEVATED BATTERY, AGAINST A FORTRESS OF MODERATE COMMAND.

*First—Interior height of the Parapet.* A tall man requires nearly 7 feet of parapet to cover him well: but in consequence of the rise of a Gun Platform, and the dip of the enemy's fire, a man standing on the tail of the platform is more exposed, than when he stands close to the parapet. It therefore becomes necessary to make the interior height of the parapet at least 7 feet 6 inches, even in Batteries erected against Fortresses of moderate command, as will be understood from the annexed figure, in which the enemies line of fire is dotted, and which shows that the height thus proposed only allows about 6 feet 9 inches of cover, to a man standing on the tail of the platform.



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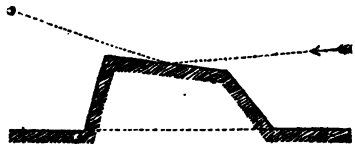
*Secondly—Thickness of the Parapet.* Shot fired with full charges from a 24 Pounder, even at very short ranges, will not penetrate more than 10 or 12 feet in earth thrown up by the shovel without ramming.* Shells act as small mines, and produce craters, that lessen the mass of a parapet. Hence on the whole 18 feet have been assumed, as the proper thickness for the parapet of a battery exposed to the fire of heavy guns and mortars. This implies its thickness at top, or minimum thickness.

*Thirdly—Dip of the Parapet.* Experience has proved, that when a cannon ball strikes any surface at a very small angle of incidence, it is glanced off again at an equal angle of reflection, without penetrating, as shown in the annexed figure. Hence the parapet of a Battery may have a dip of 1 foot in 12 without inconvenience, that is against a fortress of moderate command, in which the enemy's line of fire does not differ much from a horizontal line. A greater dip would weaken the crest of the parapet too much. Less would increase the labour unnecessarily. The dip determines the superior slope, with which it is synonimous.



*Fourthly—Exterior height of the Parapet.* This depends on the thickness, dip, and interior height:

For example, if the thickness be 18 feet, the whole dip in this space will be 18 inches, if laid out at the rate of 1 inch per foot, as before recommended. Hence from 7 feet 6 inches, the standard interior height before determined deduct 1 foot 6 inches for the dip, and the remainder, 6 feet, will give the exterior height.

*Fifthly—Interior slope of the Parapet.* In a Gun Battery, it would be most convenient to have the inside of the parapet perpendicular, which admits of the gun being well run out into the embrasure. But some slope is absolutely necessary for the stability of the work, whatever revetment be used: and the least that can be allowed seems to be in the proportion of one fourth of the height. In a parapet of

* In experiments tried at Upnor in 1817, it was found that a medium 24 pounder iron gun, fired with full charges at the distance of 200 yards against a parapet of good earth not rammed, penetrated nearly 12 feet, but never exceeded that depth. In 1829, on firing with a gun of the same nature, against a similar parapet of hard gravelly soil mixed with clay, the penetration in no case exceeded 10 feet, although the range was only 50 yards.

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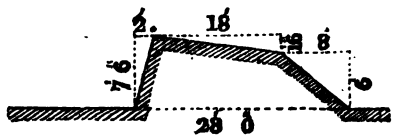
the standard height of 7½ feet, let the base of the slope be estimated at 2 feet, to avoid a minute fraction.

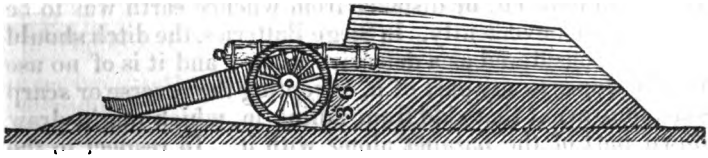
*Sixthly—Exterior Slope of the Parapet.* This being always exposed to the enemy's fire, it is useless to revet it, or to make it steeper than the natural slope of loose earth. It is best to assume it, in the proportion of 1½ of base, to 1 of height: for if made steeper, it will soon be flattened by the enemy's fire. Hence the base of this slope will be 8 feet, if the extreme height be 6 feet, as was before determined.

*Seventhly—Base of the Parapet.* This is found by adding the base of the interior slope, the thickness at top, and the base of the exterior slope together. Hence the base of the parapet of an elevated gun battery will be 28 feet, as in the annexed figure, which is a section supposed to be taken through the middle of a merlon, and which shows every dimension belonging to the parapet, that has been treated of in this article.




4. PROFILE OF THE SOLID OF AN ELEVATED GUN BATTERY, WHICH DETERMINES THAT OF THE EMBRASURES AND MERLONS.

*First—Height of the sill of the Embrasure.* Supposing the battery to be required to fire direct at the enemy's works, with full charges of powder, and also to scour the ground in front, in the event of sorties, the guns must at times be laid horizontally or nearly so. But a gun on a travelling carriage with two high wheels and a trail stands about a foot higher, than a gun mounted on a standing carriage with four small trucks. Hence the Engineer knowing before hand, on what carriages the guns are to be mounted, must make the sill of each embrasure 3 feet 6 inches high, for every gun mounted



on a travelling carriage, as represented in the first of the annexed figures; but only 2 feet 4 inches high, for every gun

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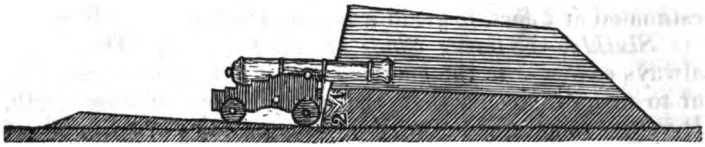

mounted on a standing carriage, as represented in the second of the annexed figures.

*Secondly—Sole of the Embrasure.* Heavy guns laid horizontally on a dead level, have the under part of their muzzle 3 feet 11 inches high above that level, if mounted on a travelling carriage: but only 2 feet 9 inches high, if mounted on a standing carriage. Hence the respective heights of sill before fixed would admit of the soles of the embrasures being laid out on a horizontal level, without interfering with the recoil of the gun. It is more usual however to give to the soles of embrasures a dip of about half an inch per foot, towards the front, in order to carry off the rain water, and also to save a little labour.

It may be almost unnecessary to observe, that all below the transverse line drawn across the parapet, in either of the foregoing figures is *the Solid of the Battery.* Above it *the Merlon* is seen in elevation. This transverse line itself denotes the sole of the embrasure: whilst the back of the solid corresponds with the sill of the embrasure.

### 5. PROFILE OF THE DITCH OF AN ELEVATED GUN BATTERY.

*First—Depth of the Ditch.* In an elevated Gun Battery, the whole or the greater part of the earth for the parapet is procured from a ditch in front. This is dug to a depth which should not exceed 5 feet, as it would render the operation of throwing it up too laborious. On the other hand too shallow a ditch would expose the diggers to the enemy's fire, during the construction of the Battery: and would increase the width of ditch, or distance from whence earth was to be obtained, inconveniently. In Siege Batteries, the ditch should never be considered as a defensive work: and it is of no use to give slopes to any part of it, excepting the reverse or scarp side, to prevent that side from falling in, which might draw down part of the parapet along with it. In respect to the front or counterscarp side, and extremities of the ditch, it is of no importance, whether they stand or fall, but at this Establishment we always finish the Ditches of our elevated

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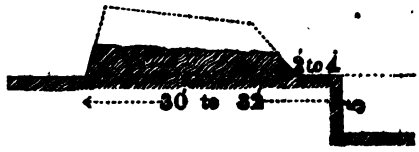
Batteries, with slopes, which gives them a neater appearance, and in order to prevent accidents from men or animals falling into them in the dark.

*Secondly—Berm.* In commencing an elevated Battery, the reverse of the Ditch is always cut perpendicularly in the first instance, allowing a berm between it and the foot of the exterior slope of the parapet. The width of this berm may vary from 2 to 4 feet, according to the tenacity of the soil, making the berm widest of course in loose soil.

The annexed figure represents the profile of the Parapet and Ditch of an elevated gun Battery in progress, thus commenced, in which the total space covered by the base of the parapet, added to the berm, will vary from 30 to 32 feet, the former dimension, namely the base of the parapet, being supposed to be 28 feet, as determined in a former article.




It may be remarked that the berm is of no further use, than to prevent the earth from falling into the ditch, which is also in a great measure prevented by giving a flat exterior slope to the parapet. In a finished Battery having an exterior slope of that description, it would therefore be of little consequence whether the berm were preserved or not.

*Thirdly—Width of the Ditch.* This is literally of no importance, and it would only be a waste of time to enter into a calculation of what it ought to be, as recommended by many speculative writers. Suffice it to say, that our Practice at Chatham has proved, that rammed earth usually occupies less space, than virgin earth, contrary to the opinion of those writers.

## 6. OF THE GENERAL OUTLINE OR PLAN OF A BATTERY. THE NECESSITY OF EPAULMENTS.

Before the profile proper for the epaulment of a Battery can be discussed, it is proper to consider the nature of the fire to which batteries may be exposed.

A siege Battery being an object of very small extent, compared with the Fortress, against which it is constructed, must necessarily be outflanked by the Fortress, either on both sides or on one only, as shown in the annexed figures.

Fig. 1. represents the face of a battery for two guns and two mortars, exposed to an outflanking fire on both its extremities, as shown by the arrows, which denote the line of fire

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of the extreme works of the Fortress, capable of bearing on it. This Battery, which may be supposed to be nearly parallel to the front attacked, evidently requires an epaulment on each of its flanks, to secure the gunners, who would otherwise be exposed to the enemy's outflanking fire, as soon as they moved a little way in rear of the parapet, which they must necessarily do in the execution of their duty.

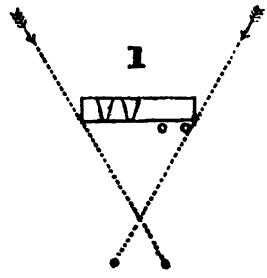
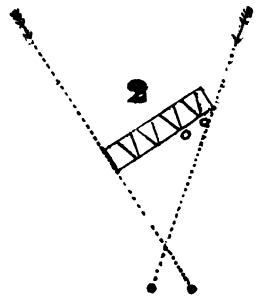
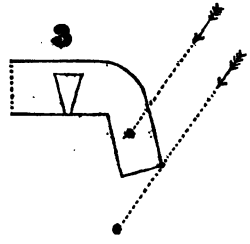



Fig. 2. represents a battery for 2 Guns and 2 Howitzers, supposed to be laid out so obliquely in reference to the front attacked, that it is outflanked by the enemy's works, on its right extremity only. Hence it requires an epaulment on its right flank, but not as a matter of necessity on the other, which by being thrown back is exposed to a direct fire only.*




On inspecting the above figures, it will be observed, that the line of fire of the outflanking guns of the supposed fortress differs from the perpendicular to the face of the Battery, by an angle not exceeding 45 degrees: and this obliquity is in reality seldom exceeded in the first siege Batteries. Hence as the epaulment is usually laid out at a moderately obtuse angle with the face of the battery, not much exceeding a right angle, it follows that the line of fire of the enemy's outflanking guns must be oblique to the epaulment also.

Now it is evident, that a cannon ball, which enters any work obliquely, at an angle of 45°, as shown in the third figure annexed, must encounter a greater resistance of earth, than if it entered perpendicularly; in the same ratio in which the diagonal exceeds the side of a square.




For this reason we have adopted 12 feet, as the standard thickness proper for the epaulments of batteries, under ordinary circumstances.

* In drawing Batteries on a small scale, guns are represented by embrasures drawn across the parapet, as in Figures 1, and 2; mortars by small circles drawn in rear of it, as in Figure 1; and howitzers by a combination of embrasures and circles, as in Figure 2.

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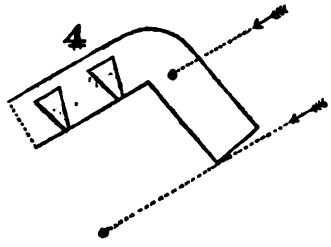
This being explained, we will proceed to the consideration of the profile of the epaulment of a battery, it being understood however, that if from peculiar circumstances, the face of a siege battery were completely enfiladed by the guns of a Fortress, as shown in the fourth figure annexed, it would be necessary to make the epaulment, which in this case would be exposed to a direct fire, as thick as the parapet itself or nearly so. Accordingly under such supposition, I would not recommend making it less than 18 feet thick. And here it may also be noticed, that a battery thus exposed to an enfilading fire requires an epaulment of greater length than usual, in order to cover the rear of the battery properly, as will be evident, from an attentive comparison of figures 3 and 4.




### 7. OF THE PROFILE OF THE EPAULMENT OF AN ELEVATED BATTERY.

*First—Height of the Epaulment.* We have usually made our Epaulments of the same height, both interiorly and exteriorly, as the parapet of the battery.

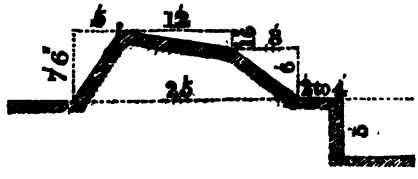
*Secondly—Thickness of the Epaulment.* We have adopted 12 feet as the standard thickness at top, under ordinary circumstances, for the reason stated in the foregoing article.

*Thirdly—Interior slope of the Epaulment.* If reveted, it should be the same as that of the parapet, but to save materials, we have recently ceased to revet our epaulments, and consequently we have given them an interior slope having 5 feet of base, that is in the proportion of two thirds of the height.

*Fourthly—Exterior slope of the Epaulment.* The same as that of the parapet.

*Fifthly—Base of the Epaulment.* This is found like that of the parapet, by adding together the base of the interior slope, the thickness at top, and the base of the exterior slope.

According to the dimensions before stated, the base of an unreveted epaulment will therefore be equal to 25 feet, as in the annexed figure, which shows the profile complete, including also the berm and part of the ditch.

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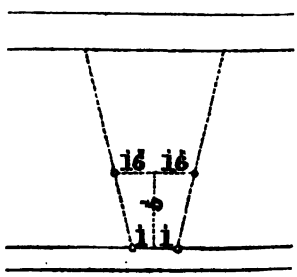
*Sixthly—Ditch of the Epaulment.* This should be cut to the depth of 5 feet like that of the parapet, leaving a berm.

*Seventhly—Berm of the Epaulment.* This may vary, like that of the parapet, from 2 to 4 feet, according to the nature of the soil.

## 8. OF THE EMBRASURES OF ELEVATED GUN BATTERIES.

The form of an Embrasure, as it appears in the profile of the parapet has already been noticed. To explain the whole of this essential part of a gun battery, it remains to treat of the outline of an Embrasure in plan, and of such of its slopes, as have not yet been described.

Under ordinary circumstances, the object line, which is the central line, or line of fire of each embrasure, is always perpendicular to the parapet or face of the battery; and the base of the embrasure is so laid out, that its width at the neck or in rear is 2 feet, whilst its width at the distance of 5 feet towards the front is increased to 3 feet.




The tracing is commenced, as soon as the parapet has been raised to the level of the solid, which corresponds with the sole of the proposed embrasure. On this level, or rather plane, it not being exactly horizontal, 5 feet are measured perpendicularly on the proper line of fire of the embrasure, from the interior slope towards the front; and at the two extremities of this line, the respective widths above mentioned are set off at right angles, one half of each to the right, and the other half of each to the left of the line of fire, as shown in the annexed figure, which is a plan of part of the battery, whilst in progress. The four points thus obtained, supposed to be marked by short pickets in the figure, determine the splay or oblique direction of the cheeks of the embrasure, which are represented by the two oblique dotted lines, and are produced as far as the exterior slope of the parapet.

By this rule, the obliquity at the base of the embrasure of a gun battery is in the proportion of 1 foot in 10, in each cheek, making the total splay of both sides equal to one foot in five.

When heavy guns are repeatedly fired from a battery with full charges of powder, the concussion of the air acts with considerable violence upon the cheeks of embrasures, so that if the latter were unreveted, the only form at which

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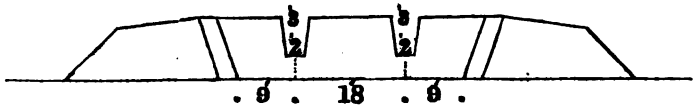
they could stand permanently, would be with wide openings, and very gentle slopes on each side, so that the merlons and embrasures thus fashioned would assume the appearance of rounded hills with intervening valleys in nature, as shown in the annexed figure, which we shall suppose to be the rear

elevation of a two Gun Battery, of this description, having an epaulment on each flank.

So far as mere stability is concerned, the above simple form of embrasure would be the best, but as it would expose the gunners too much, the neck of the embrasure is made narrow and with little or no slope, in order to cover them as much as possible, whilst the slope is increased gradually and considerably towards the front.

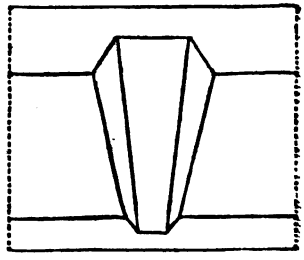
The annexed figure represents the rear elevation of a two gun battery supposed to be reveted on the above principle, in which the neck of each embrasure is 2 feet wide at bottom




and 3 feet wide at top, which is a very moderate slope, being in the proportion of one eighth of the height only, on each side.

At the distance of about 10 or 12 feet towards the front, the slope of the cheeks may be so much increased, that the base shall be equal to about half the height, and from thence towards the mouth of the embrasure, it may be increased in the like proportion.

Hence the cheeks of an embrasure are what mechanics term "in winding," that is to say, they are not in the same plane, throughout their whole extent. The annexed figure represents the plan of an embrasure, having an uniformly increasing slope from rear to front, which arrangement, however, does not always prevail in practice; for if the rear part of the cheeks only be reveted, which is sometimes the case, the earthen



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slopes in front require to be more suddenly flattened, than is necessary for the reveted portion.

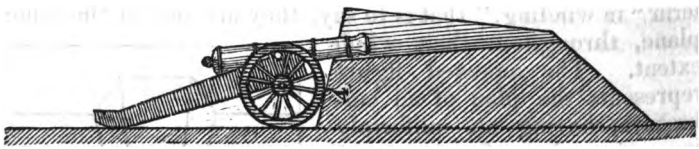
When gabions are used for the revetments of a battery, the necks of the embrasures must be made nearly of equal width throughout, by setting up the two extreme gabions in the interior of each merlon, parallel to each other or nearly so, but a great increase of slope must take place in each cheek, from thence towards the front, as was before described.

These two gabions will stand a good while, before they are materially injured, by the firing of their own guns, for the muzzle even of a medium 24 pounder, when properly run up, projects beyond them. Hence the concussion of the air passes these two gabions, but soon destroys the next pair or couple of pairs of gabions immediately in front of them; for the effect of these explosions is always most violent, opposite to, and for some feet immediately beyond the position of the muzzle, at the period of firing: but does little injury to the neck of the embrasure, nor even to the front part of the cheeks, at the distance of about 8 feet from the muzzle.

### 9. OF COUNTERSLOPING EMBRASURES FOR HOWITZERS, OR FOR GUNS, WHEN INTENDED FOR RICOCHET FIRING EXCLUSIVELY.

Howitzers are generally used for Ricochet firing, and are laid at an angle of elevation of not less than six and usually not exceeding ten degrees.

Guns intended for Ricochet firing exclusively are also laid in the same manner. This raises the muzzle considerably higher, than in the direct firing with full charges, and as the shells, or shot always rise in quitting the howitzer or gun, it is unnecessary to make the sole of the embrasure with a dip towards the front. Hence the sill of an embrasure, intended exclusively for Ricochet firing may be made about 6



inches higher, than that of a common embrasure, and the sole of the embrasure may have a rise towards the front of about one foot in ten, as shown in section, in the annexed figure.

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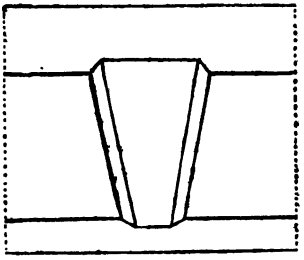
Embrasures thus constructed for ricochet firing only, are termed *Countersloping Embrasures*, from the circumstance of having their slope at the sole, laid out in a contrary manner to that of common embrasures for direct firing. In those, which are intended for ten or even eight inch howitzers, the width at the neck may be increased to $2\frac{1}{2}$ feet, instead of 2 feet, which is sufficient for guns.

Moreover in tracing an embrasure of this description, which cannot be entirely done, until the sole, shall have been raised in front to the proper height, and with the regular counterslope fixed upon, the width at the distance of 5 feet to the front, may be increased to $4\frac{1}{2}$ feet in a countersloping howitzer embrasure, and to 4 feet in a countersloping gun embrasure, instead of making it only 3 feet, as was prescribed for a common gun embrasure.

The slopes proper for the cheeks of countersloping embrasures should be determined by the same rule, as those of common embrasures, but in consequence of the rise to the front, the vacant space is altogether so much diminished, and the solid so much increased, that the labour of forming the parapet of a battery intended for Ricochet firing exclusively is greater than in a common battery, but it affords more cover to the gunners in proportion.



In plan, the sole of the countersloping embrasure cuts itself out a very little way beyond the exterior crest of the parapet, and the slopes appear inconsiderable, as shown in the annexed figure.

In batteries intended exclusively for Ricochet firing, not only the form of the embrasure, but the arrangement, or even the construction of platform used, may differ from those which are proper for common gun batteries, as will be noticed hereafter.

## 10. OF SPLINTER PROOF TRAVERSES.

Siege Batteries are very rarely exposed to an enfilading or flanking fire of heavy guns; and for this reason substantial traverses are seldom necessary. Slight traverses only are therefore usually constructed, as a protection against shells.

*Splinter proof traverses*, as these are termed, are generally made perpendicular to the parapet of a battery but

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disengaged from it, with a passage between not exceeding 2 feet in width, so that the gunners can pass round a traverse by both its ends, to take refuge on one side of it against the splinters of a shell, which is about to burst on the other side of it.*

Traverses in the interior of a Battery must be reveted on all sides, to prevent them from taking up too much room; and as splinter proof traverses never have a base of more than 6 feet, it is unnecessary to give them the regular slope of one fourth, which is proper for the revetments of more substantial works.

The length of a splinter proof traverse may be about 16 feet: and its thickness or width at the base from 4 to 5 feet.

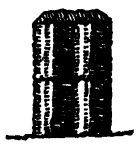
Gabion traverses are the most convenient; which must be built in two courses to obtain sufficient height.

The annexed figure represents as strong a splinter proof traverse, as need be used. It has two rows of gabions, in each course, but those of the lower course are supposed to be separated more than the upper ones to give more stability, if deemed necessary. Two fascines are used, one on each side, between the lower and upper courses of gabions.

When the base of the traverse is increased by separating the lower rows, a little, as shown in the above figure, the two extreme gabions at each end must be brought close together, which will give the ends a curved appearance.

The ground plan of a splinter proof traverse thus formed with two rows of 8 gabions each, is shown in the annexed figure, in which the dotted line marks the position of the interior base line of the parapet of the battery.

Instead of separating the two lower rows of gabions, as in the foregoing construction, they may be placed close together, and the uppermost gabions may be placed over them, without any intermediate course of fascines. This arrangement, by reducing the width of the base from 5 feet to 4 feet is a saving of room, and consequently of labour, for in proportion as the number and size of the traverses in a battery are increased, the length of the parapet of the battery, and of course the labour of constructing it, must be increased also.



* The Ordnance in a Siege is necessarily fired so slowly, that no inconvenience arises from this practice, which may save lives.

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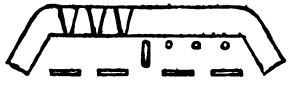
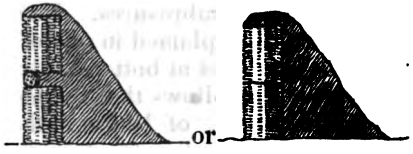
Some Officers have recommended, that the upper course of gabions in a traverse of this description shall consist of a single row only, as shown in the annexed figure, but I am afraid, that this construction which saves 8 gabions per traverse, but very little labour, would be too weak. Whatever may be wanting to make up height, above the upper course of gabions may consist of earth, faced with sods.

Splinter proof traverses would be seriously injured and indeed partly demolished, by a shell lodging upon and bursting in them: but their repairs are so easy, that it is not worth while to make them more substantial to meet this contingency.

Splinter proofs might also be placed in rear of a battery for a similar purpose, which arrangement has not however been usually adopted. The annexed figure represents the plan of a battery for three guns, and three mortars, with an epaulment on each flank, and having one splinter proof traverse in the center, of the usual construction, and four reverse splinter proofs in rear of the platform.

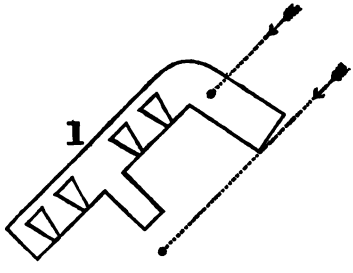


Reverse splinter proofs need not be reveted in rear, but on the front side and ends only. Hence their profile may be as in the annexed figures, showing the front built with two courses of gabions, with or without an intermediate course of fascines, as may be deemed expedient.




## 11. OF SUBSTANTIAL TRAVERSES, PROPER FOR BATTERIES EXPOSED TO AN ENFILADING FIRE.

Under the peculiar case of a Battery being exposed to a completely enfilading fire, which was before adverted to, it would be necessary, not only to have an epaulment nearly equal to the parapet in thickness, but to have here and there traverses of a more substantial nature, than mere splin-

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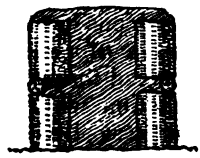

ter proofs. Such traverses should be from 9 to 12 feet thick at the base, attached to the parapet, and not less than 18 feet long, as shown in the foregoing figure. They may be introduced between every two or three guns, and must be reveted with the usual materials: but with a less slope than usual, or without any, if reveted with gabions, as represented in profile in the second figure annexed.

### 12. OF THE SPACE PER GUN, OR PER MERLON, ALLOWED IN LAYING OUT THE FACE OF A BATTERY.

The space of 18 feet per gun has usually been allowed by us, and it appears to me to be the least that ought to be allowed for heavy guns, in a Siege Battery. It is rather more than enough for working the guns, even when mounted on travelling carriages, which take up greater room, than standing carriages: but any diminution of this space would weaken the merlons too much.

For example, it is sufficiently evident, that the width of the embrasure at any point must determine the corresponding width of the merlon, as the two together must exactly make up the space of 18 feet in length, allowed from center to center of adjacent embrasures. Now by the dimensions of the embrasure, as explained in one of the foregoing articles, the width being 2 feet at bottom and not exceeding 3 feet at top, at the neck; it follows that the merlon will have the respectable width in rear of 16 feet at the base, and not less than 15 feet at the top: but in front, on account of the great splay and slopes of the embrasure at the mouth, the width of the merlon will be reduced to about 12 feet at the base, and to about 8 or 9 feet at the top only.

Indeed even these last named dimensions might be considered insufficient, if it were not for the property of sloping surfaces before mentioned, which causes a cannon ball from the fortress, which enters by the mouth and strikes one cheek of an embrasure, to glance off without penetrating through the merlon on that side. Such a ball is not therefore likely to prove fatal to those men who are covered by the merlon, but to those only who stand immediately behind the embrasure, and not always even to them, for if it should strike the very sloping part of the cheek, it may be reflected upwards.

Whenever a traverse is introduced between two embrasures in a Gun Battery, it is proper to increase the space

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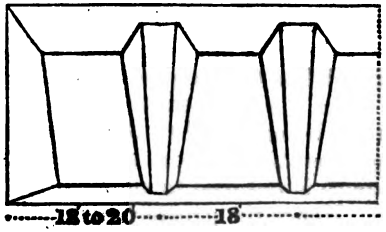
between these two Guns, and consequently the width of the intermediate merlon, by a dimension not less than the width of the traverse at its base. This prevents the men who work the Guns on each side of a traverse, from being more exposed there, than if they were behind any of the other merlons.

In a battery reveted with fascines or sand bags, the additional space may be made exactly equal to the width of the base of the traverse, whatever it may be: but in a battery reveted with gabions, this additional space must not in any case be an odd number of feet. If therefore the width of the base of a traverse, proposed to be made in rear of such a battery be 5 feet, or any other odd number, let this extra space be increased by 1 foot, in order to make it an even number.

13. OF THE SPACE THAT MUST BE ALLOWED, FOR THE EXTREME HALF MERLON AT THE FLANK OF A BATTERY, WHEN FINISHED WITHOUT AN EPAULMENT.

The regular merlons of a gun Battery, when laid out at the usual central intervals of 18 feet apart, have only an exterior width of about 9 feet at the top, one half of which dimension would evidently be insufficient. If therefore the flank of a battery be finished without an epaulment, the space allowed for the extreme half merlon on that side must be increased accordingly. If our Batteries were reveted at the extremities, according to the system recommended in Foreign Authors, the least that could be allowed for this extreme half merlon, in the tracing of the interior base line of the parapet would be 13 or 14 feet; but as we dispense with such revetments, it is necessary in this case to allow from 18 to 20 feet, in consequence of the greater base required for the natural slope of unreveted earth. By this arrangement, supposing the earth to stand at 45 degrees, or with a slope of 1 to 1, the extreme half merlon of a battery terminating without an epaulment will have the same exterior dimensions, and consequently will be as substantial as a common merlon; as will be evident on inspecting the annexed figure,



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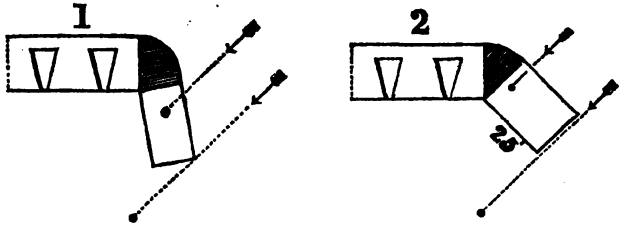
which represents the plan of part of a Battery having one extremity thus finished.

Hence besides the regular space of 18 feet per gun, and the space of 4, 5 or 6 feet extra, for each splinter proof traverse, it is necessary in calculating the length of the interior base line of the parapet of a Battery, to add also from 9 to 11 feet extra, for the extreme half merlon, if one flank should be finished without an epaulment.

### 14. OF THE EPAULMENT AND SHOULDER OF A BATTERY, IN PLAN.

If from the interior angle at the extremity of a battery, where the base line of the parapet meets that of the epaulment, two lines be drawn across the whole base of the work, one perpendicular to the parapet, the other to the epaulment, the portion cut off between these two lines is *the Shoulder or Junction* of the parapet and epaulment.

When the exterior angle is rounded off to save labour, the shoulder nearly assumes the form of the sector of a circle, as shown in the two annexed figures, in which it is shaded dark by way of distinction, and in all cases, the shoulder sufficiently strengthens the extreme half merlon adjacent to it, for the shoulder is virtually a prolongation of the parapet.




In Fig. 1, the splay of the epaulment is laid out in the proportion of 1 to 4, so that the interior angle of the shoulder does not much exceed a right angle, and the sector is not much less than a quadrant.

In Fig. 2, the interior angle is supposed to be more obtuse, being equal to 135 degrees, which exceeds a right angle by 45 degrees, but by this arrangement the sectoral space is reduced to an octant.

Hence the greater splay, which evidently diminishes the comparative magnitude of the shoulder, would lead to a saving of labour, if it did not at the same time throw forward

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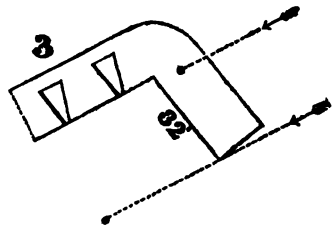
the Epaulment more into the direct fire of the extreme works of the fortress, as shown in Fig. 2, which counterbalances the former advantage, by rendering it necessary to make the thickness of the Epaulment itself greater in proportion, than would suffice for Fig. 1. Upon the whole therefore, it appears to me, that it is best to lay out all epaulments with rather moderate splays, or at an angle not much exceeding a right angle.

Under ordinary circumstances, 25 feet appears to be a sufficient length for the interior base line of the epaulment, which allows about 18 feet for the length at top, the remainder going to the slope. Now as the enemy's fire is generally oblique to the face of the battery, as shown in the two preceding figures, this length is quite sufficient to cover the men at the rear of the extreme platform.

If on the contrary the Battery were exposed to an enfilading fire, so that the path of the shot fired by the enemy would either be in the alinement of the interior of the parapet, or parallel thereto, instead of diverging towards the rear: in this case the epaulment should be at least 32 feet long at the base, as shown in the third figure annexed, which would allow 25 feet at the top exclusive of the slope. This would just be sufficient to cover the gunners properly, when employed in the rear of the platforms.




15. METHOD OF ROUNDING OFF THE EXTERIOR ANGLE OF THE SHOULDER.

After the parapet of a battery and one epaulment are traced on the ground, which is done by two sets of parallel lines, the exterior angle of the shoulder is rounded off, by describing an arc that shall touch the two lines which form that angle. As the thickness of the parapet at the base is greater than that of the epaulment, the radius for describing this arc must be equal to the lesser dimension of these two. Hence in the tracing of a Battery if the parallel lines for marking the parapet be 32 feet apart, whilst those for marking the epaulment are only 29 feet apart, the radius for rounding off the exterior angle of the shoulder must be 29 feet: and the center for describing the arc by which this is done, must be



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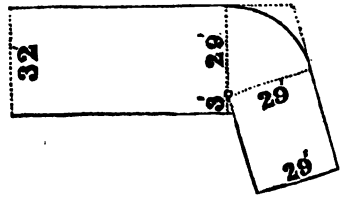
in the prolongation of the interior base line of the epaulment, at the perpendicular distance of 3 feet in front of the interior base line of the parapet, as shown in the annexed figure, 3 being the difference between the two given thicknesses above mentioned.




## 16. COMMUNICATIONS OR PASSAGES INTO THE DITCH OF AN ELEVATED BATTERY.

Every Elevated Battery ought to have a communication with the ditch in front of it, which should be made on the most retired flank, or on both flanks of the Battery, in reverse of and screened by the extremity of an Epaulment. This communication should consist of a small trench in the form of a ramp, about 3 feet wide, descending gradually to the level of the ditch, with a berm on the side of the epaulment, to prevent the earth of that work from giving way, and falling into it.

Fig. 1, which is the plan of an elevated Battery in progress represents this arrangement. The ditch D communicates at its two extremities, with the Ramps R R, immediately in rear of the epaulments of the Battery.

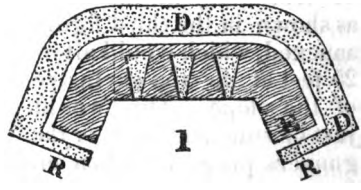



Fig. 2, is a longitudinal section of one of these ramps, showing its gradual descent from the interior of the Battery to the ditch D. In this figure the extremity of the epaulment E, together with one side of the ramp R, appear in elevation.

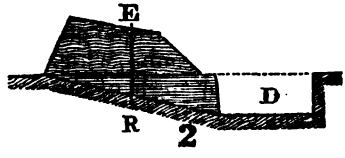



Fig. 3, is a transverse section of the same ramp, taken about half-way down the slope, according to the line E R, in figure 1, or the vertical plane marked E R, in figure 2, so that a part also of the epaulment is shown, in longitudinal section.

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Passages of this description* afford the means of visiting and relieving the working parties, in the ditch of an elevated Battery whilst in progress, without exposure to the enemy's fire, and without being obliged to jump into, and scramble out of the ditch, in an inconvenient manner.

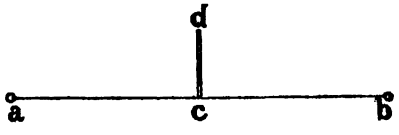
17. OBSERVATIONS ON PRACTICAL GEOMETRY ON THE GROUND, AS APPLIED TO THE TRACING OF SIEGE BATTERIES.

*First—Straight Lines.* It may almost appear superfluous to explain, that straight lines are marked on the ground, by stretching a cord, tape or tracing line, and that all points that are to be preserved are marked by short pickets driven into the earth, called tracing pickets, to which such cords are attached.

*Secondly—Arcs.* An arc is described by moving a piece of cord round a fixed picket as a center, to which one end of it is made fast. The length of the cord must of course be equal to the proper radius. A short picket may also be attached to the movable end, if you think proper. By day light, the arc thus described may be traced by spitlocking the ground, that is by marking it with a pickaxe or spade. By night a number of white pickets may be driven along the curve, which being connected by a white tape stretched along their convex side, will mark it sufficiently.

In no case do I recommend the dimensions of field works to be marked by pacing; for correct measurements by a 50 feet tape, or even by a 6 feet rod, may be taken as quick as a man can pace, or nearly so. But in respect to right angles, and splays, or even slopes, these may be set off, by a good eye with sufficient accuracy, for all the purposes of a siege battery, without using either a ground square, or bevel, or any of the other instruments commonly employed by mechanics for similar purposes.

*Thirdly—Perpendiculars.* For example, supposing that a straight line a b is marked on the ground by a cord stretched between two pickets: and that it is required to trace a second line perpendicular to it at the given point c. To this point apply a 6 feet rod c d, at right angles as nearly as you can judge by the




* First suggested by Lieut.-Col. Burgoyne.

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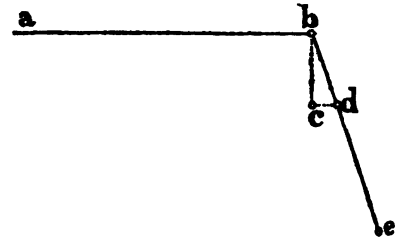
eye. After a little practice, you will seldom fail in performing this operation correctly or nearly so: and thus the line of fire, or center line of an embrasure, may be determined after the parapet of a battery has been traced.

In like manner, it is evident, that if the rod be laid down first, in the direction of a given object, it will be equally easy to trace a straight line of greater length perpendicular to it, by the cord and pickets.

*Fourthly—Splays.* In respect to splays or oblique lines, that are to be traced on the ground, each of these may be resolved into the hypothenuse of a right angled triangle, and marked accordingly; by first tracing two lines at right angles to each other, to fix the proportion of the required splay; and then stretching a cord to complete the triangle.

For example, let us suppose that a b is the interior base line of the parapet of a battery, and that the epaulment is to be traced in rear of it from the extreme point b, with a splay or obliquity of 1 foot in 4.




Then it is evident, that if the line b c be traced from the point b perpendicular to a b, and if another line c d, be traced outwards perpendicular to b c: and if the first of these perpendiculars be made 6 feet long, and the second $1\frac{1}{2}$ foot long, that is in the proportion of one fourth part of the former, which may easily be done on the ground by a couple of 6 feet rods, these two perpendiculars will form the sides of a right angled triangle, of which the hypothenuse b d, has the required splay of 1 foot in 4, in reference to the original line a b. Hence by stretching a cord from the picket b, over the point d, and extending it to e, or so far as may be allowed for the length of the interior base line of the epaulment, the latter line will be traced on the ground, with sufficient accuracy.

*Fifthly—Slopes.* In respect to slopes, such as the interior slope of a parapet, these also may be regulated with sufficient correctness by a good eye. Let us suppose for example, that a wooden profile A B is to be set up at a slope of 1 foot in 4, which is the usual slope for the interior revetment

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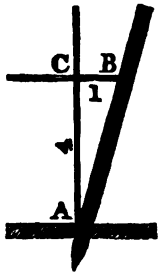
of the parapets of batteries. At the point on the ground, which is intended for the foot of the slope, let the Engineer direct a man to stand at some little distance from him, and hold up a rod A C perpendicularly, as shown in the figure. At the height of 4 feet let him cause another rod C B to be held horizontally, so as to project 1 foot beyond the former. By this means he may determine the slope A B, with sufficient accuracy; for a person must have a very bad eye indeed, who cannot distinguish even a small deviation from the vertical or horizontal.




By the same method a gabion might be placed at any required slope, without the use of other instruments than a couple of rods, and without the necessity of setting up a wooden profile.

It is of importance that an Officer should be prepared to trace, with as few superfluous instruments as possible. If any instrument at all be used, none is more convenient than that, which after having been approved in the practice of this Establishment, has recently been adopted as an article of store in the Department, under the title of Field Level, and which can answer the several purposes of the Artificer's Level, Bevel, Battering Plum Rule, and Square.

## 18. RULES FOR TRACING AN ELEVATED GUN BATTERY ON THE GROUND.

The first thing to be marked, in the tracing of an elevated battery, is the interior base line of the parapet, which an officer with a good eye, may lay out in a proper direction, without the aid of any instruments; but if he should doubt his own accuracy, let him mark an object line first on the ground, in the direction of some suitable point of the enemy's work, that is to be fired at; which being done, let him set off the interior base line of the parapet, at right angles to it, by means of an instrument.

According to the rules developed in the preceding articles, the proper length of the interior base line of the parapet, will depend on the number of guns and traverses. Let us suppose that we are to trace a battery for 6 guns, with two splinter proof traverses, one between every two guns, and two unreveted epaulments, one at each end: and let us further suppose, that the traverses are to be 5 feet wide

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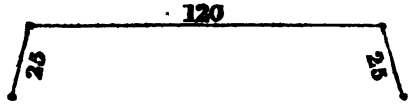
at the base. The extreme length of the interior base line will therefore be as follows:—

| | |
|---|---|
| 6 guns at 18 feet each ..... | 108 |
| 2 traverses at 5 feet each ..... | 10 |
| Total | 118 |

The above length will suffice for the parapet, in the tracing of a fascine or sand bag battery; but for the reason before explained, if we suppose that the proposed battery is to be reveted with gabions, the additional space added to the length of parapet for each traverse must be an even number of feet. Hence 6 feet extra per traverse would be required instead of 5. This would render it necessary to increase the length of the interior base line of the parapet from 118 to 120 feet. Let us suppose the last named dimension to be adopted. This length must therefore be marked on the ground, by a tracing line, or white tape, with a picket at each end of it. A measuring tape of 50 feet is the most convenient measure.

The interior base lines of the epaulments must next be traced, agreeably to the rule explained in the preceding article. If therefore we suppose that neither of the epaulments is exposed to a direct fire; 25 feet will suffice for this purpose, and a splay of about 1 foot in 4 may be given to both of them. The length of each must also be marked by a tracing line or white tape, and a picket, as in the annexed figure.




The next thing necessary is to mark the exterior berm line, or the reverse of the ditch of the battery, which is done by tracing three lines parallel to the former and in front of them, at the distances before determined in considering the profile of the battery, of which the Engineer officer should always make a rough sketch, before he commences his tracing.

On a reference to the profile of the parapet of an elevated gun battery in progress, given in article 5, page 7, it appears that the whole ground covered by the base of the

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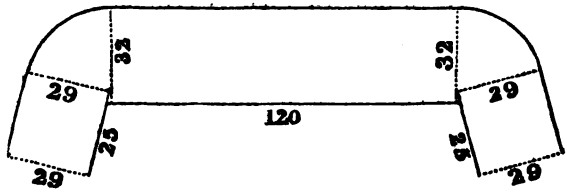
parapet and the berm is from 30 to 32 feet; and if we suppose the soil to be rather loose, the latter dimension is most proper.

At the distance of 32 feet therefore in front of the interior base line of the parapet, a second line must be traced on the ground, to mark the reverse of the ditch of the parapet.

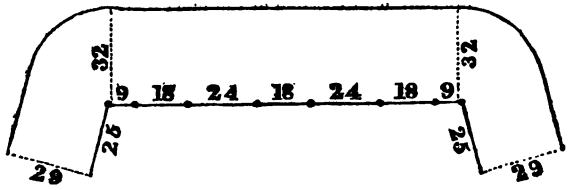
In like manner, on a reference to the profile of the epaulment given in article 7, page 9, it appears that the base of that work together with a berm of 4 feet, covers a space of 29 feet: and at this distance therefore, a second line must be traced on the ground, in front of and parallel to the interior base line of each epaulment; and the ends of the epaulments must terminate perpendicularly.

The exterior angle of each shoulder must next be rounded off, by the rule before explained: but whether this be done on the ground with strict geometrical accuracy or not, is a matter of little importance.

The annexed figure represents the tracing of the battery, in the state of progress now described, with the interior base lines and exterior berm lines of the work, laid down, and the latter rounded at the angles, according to rule.




In a gun battery, the position of the center of each embrasure must also be marked by a picket, on the interior base line of the parapet. This requires the whole space of 120 feet to be subdivided into 2 half merlons of 9 feet, one at each extremity of the base line, 3 common merlons of 18 feet, and 2 large merlons of 24 feet, the latter having an extra length of 6 feet, on account of the splinter proof traverses, which are to be situated behind them.

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The foregoing figure represents the position and distance of the several embrasure pickets thus arranged: and with this addition, the tracing of our elevated gun battery is now completed, every line and point, that ought to be marked on the ground being shown, and their dimensions figured. And in this state, every thing is ready for the commencement of the work.

When the battery is to be traced by a measuring tape, it may perhaps be best to lay out the whole interior base line first, and to subdivide it afterwards: but when the battery is to be traced by a 6 feet rod, it will save trouble to measure the successive subdivisions in regular order, from one end of the base line to the other, and to mark them by pickets, as you proceed.

## SECTION II.

### OF THE REVETMENTS OF BATTERIES.

#### 1. GENERAL OBSERVATIONS.

In the practice of this Establishment, we have recently adopted the system, of reveting only the interior of the parapet and the cheeks of the embrasures of gun batteries, these being the only parts of the work that absolutely require it. Formerly we also gave interior revetments to our epaulments, which have since been discontinued as superfluous.

The materials, generally used in the field for this purpose, are gabions, and fascines, or sand bags, with the occasional aid of sods. More substantial reveting materials such as casks, or wooden frames and planking, might also be used; but such expedients, especially the latter, are more suitable for the batteries made in an intrenched position or in a fortress besieged, than for the temporary batteries of a besieging army.*

* Captain Moncrieff, who was one of the most distinguished Officers of the Corps in the American War, and who after attaining the rank of Lieut. Colonel was subsequently killed before Dunkirk in 1793, made use of timber frames and planking for his defensive works, with credit and success, in the memorable defence of Savanna, against the French and Americans in 1779. In the still more memorable defence of Gibraltar a few years afterwards, the Batteries on the rock were constructed in the most substantial manner; strong caissons of ship timber filled with rammed earth being used for the merlons, and casks being abundantly employed for the revetments of traverses, &c.

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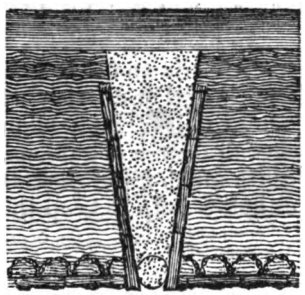
## 2. OF GABION REVETMENTS.

In reveting the interior of an elevated gun battery with gabions, we always lay one course of fascines along the interior base line of the parapet, over which the first course of gabions is afterwards placed. The ground may be grooved a little, and when uneven, must be smoothed, so as to give to the fascines used a regular foundation, which should not, however, be cut more than two or three inches beneath the general level of the surface. The back of each gabion is made to rest on the fascine below, whilst the front of it is nearly on the original ground level, and thus the proper slope of one fourth of the height is obtained. The gabions must be filled with earth, moderately rammed, so as not to strain them, and the whole mass of earth composing the lower part of the parapet is carried up to the same level in rear, but about a foot lower in front. The solid is then regularly completed to its proper level, or rather slope, opposite to each embrasure picket, after which the two cheeks of each embrasure are marked out by a couple of fascines, making them 2 feet apart at the neck, and 3 feet apart at the distance of 5 feet to the front, according to the rule before laid down. At the same time, a second course of fascines is added to the interior revetment of the parapet, which are laid over the gabions, extending in each merlon, from one embrasure fascine to the other, and filling the interval between these two.

The foregoing figure is a section of the parapet of an elevated Battery, at this stage of progress, supposed to be taken across one of the proposed merlons.

The second figure annexed represents the plan of a one-gun portion of an elevated gabion battery at the same period, showing the solid just completed, and the embrasures marked by a couple of fascines; and the second course of fascines in rear of the parapet placed. The embrasure fascines are carried back as far as the interior slope of the par-



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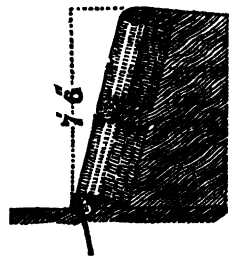
apet, so that their ends are seen in a rear elevation of the parapet of the battery. *(See also the Figure in Page 33.)*

After the whole of the fascines thus laid, which mark the form of the embrasures and merlons, are backed with earth, as much as may be necessary, a second course of gabions is placed over them. Those for the parapet, or back of the merlon, are carefully placed by the same rule, as the first course of gabions below, so that when finished the whole interior revetment of the parapet shall have the same uniform slope of one fourth of its height throughout. The gabions in the cheeks of the embrasures, on the contrary, are placed with a variable slope, as will afterwards be explained. In the mean time we will proceed with the parapet.

Although our gabions measure only 2 feet 9 inches high in the web, they are found to average 3 feet each in a parapet, owing to the projecting ends of the pickets. Hence the second course of gabions will very nearly complete the parapet to the height of 7 feet 6 inches. The small deficiency which usually remains, may either be made up with sods or rammed earth.



The annexed figure is a section of the interior revetment of a parapet, thus finished, as taken through the center of a merlon.

Under the peculiar circumstance, of a battery constructed against a very commanding work, it might be necessary to raise the parapet higher than the usual standard of 7½ feet. In this case, whatever height may be required, over and above that which is afforded by the second course of gabions, must be made up with fascines. Thus for example, if the parapet were required to be 9 feet high, it would be proper to add two courses of fascines at top: but if any part of the height necessary should involve a fractional part of a fascine's height, this may be reveted with sods.

In a gabion battery, the foundation course of fascines is picketed down to the ground, by short pickets driven at intervals of 3 or 4 feet apart; but the remaining courses of fascines, unless there should be more than one above the second course of gabions, which very seldom happens, require much fewer pickets, as the gabions immediately above or below help to keep them in their places.

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The following figure is the rear elevation of a two gun portion of an elevated Battery reveted with gabions. In this figure, the two gabions at the necks of the embrasure,

are made to assume a small degree of slope, which may usually be done, because the gabions one with another, occupy rather less than the regular average space of 2 feet each, when placed very close together, so that those of the upper tier will generally admit of being closed at top and eased at bottom, to favour this arrangement. If not, the neck of the embrasure may be made of equal width throughout, without attempting the kind of slope alluded to.

On considering the above figure, the propriety of the rule before laid down will be evident, namely that it is necessary that the extra length of parapet, allowed for each traverse in a gabion Battery, must either be 4 feet, 6 feet, or some other even number of feet; in order that the merlons may always be reveted with an integral number of gabions. For a fraction of a gabion would be very inconvenient, as it would leave a blank space, in the revetment, that would require to be filled in an aukward manner with sods, or with a piece of fascine set up on one end, and secured by pickets.*

In a battery of this description, the strongest gabions should be selected for the embrasures; which are first marked out by a couple of fascines, as was before mentioned, upon which these gabions are to be placed. Those at the neck of each embrasure have little or no slope, so that they leave the opening nearly of the same width at top, as at bottom. The slope of the remaining gabions of the cheeks of the embrasure is gradually increased, from thence towards the front. When 5 or 6 gabions only are used in each cheek, for it is not necessary to revet the whole extent of the embrasure, the most advanced gabions may be placed with a slope of about one half of their height. Beyond these, an

* In like manner, and for the same reason, it is obvious, that if casks were used in the revetments of a battery, the space from gun to gun must be so regulated in reference to the actual diameter of the casks, that the back of each merlon shall be formed by an integral number of casks.

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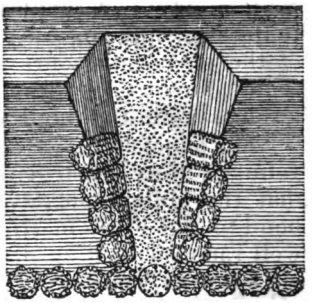
increasing slope of earth may be allowed, in a still greater degree towards the mouth of the embrasure, in conformity to the principle before explained in Section I, Article 8. The annexed figure represents a gabion embrasure of this description in plan, in which the most retired gabions are nearly perpendicular, whilst the most advanced ones lie partly on their sides.



In gabion Batteries, it is unnecessary to tell off any men for builders, as there is not constant employment for them; each tier of gabions, and each course of fascines required, being placed by men taken off from the other duties of the battery, for a short time.

### 3. OF FASCINE REVETMENTS FOR BATTERIES.

The fascines, used in the revetments of a battery or other work, are built in successive courses, and are bonded with the earth, which they are to retain, by means of pickets, in the proportion of about six to an 18 feet fascine, or of one picket to 3 feet of length of parapet, in every course.

The ground may be prepared for the first course of fascines, in the manner before explained, by cutting a small groove 2 or 3 inches deep, and paring off all irregularities in the general surface, along which the interior base line of the parapet has previously been traced. The first fascine may be fixed by shorter pickets than usual, if the ground be hard.

Great pains must be taken, to give to the successive courses of fascines their proper slope of one fourth of the height, observing that in ramming the earth in front of them there is always a tendency to force them back, and thereby to diminish the slope, which circumstance must be kept in view and guarded against.* Each course of fascines must have the earth raised to the same level at top, before another course is laid.

The pickets must generally be driven obliquely downwards into the earth, so as to form an angle of about 45 degrees with the interior slope. A very few only,† and those

* The same remark applies, but in a less degree to a Gabion Revetment.

† Not exceeding one third or one fourth of the whole number of pickets.

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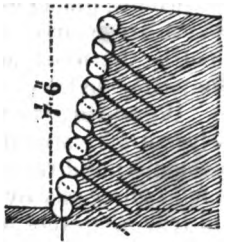
the thinnest that can be found, may be driven through the centers of several courses of fascines, in a direction parallel to the said slope, in order to connect the whole. The joints of the successive courses should be broken. Those of the same course are vertical, and formed by the butting of the fascines against each other end to end.*

The annexed figure represents the profile of a fascine revetment, thus constructed: and we found by experience that the oblique pickets gave such a bond to the work in stiff earth when well rammed, that in demolishing our old batteries, a number of pickaxes were usually broken in attempting to tear away the fascines from the parapet; for which reason it was made a standing order of the Establishment, that in pulling down a revetment of this description, the earth should always be cleared away from the back of three or four courses of fascines at a time, before any of the latter were removed.




The fascines used for the cheeks of embrasures must never bond into those, which line the backs of the merlons. Following this rule, the whole of the fascines of the cheeks must extend as far as the interior slope of the parapet; so that they will all appear as headers, when viewed from the interior of the battery.

The annexed figure, which is the rear elevation of a two Gun portion of a Fascine Battery, exemplifies this arrangement.

The reason for not allowing the fascines used in the cheeks of the embrasures, to break bond with those used in the interior slope of the parapet, is that the former are much more liable to be injured by the enemy's shot than the latter, and are also continually deranged by the explosion of the guns

* Many rules for fascine work have been given in French and German Authors, very different from the above, such as having the ends of fascines made rough, and entering the rods at the end of one into those of another; driving all the pickets in a direction nearly vertical; using anchoring withes and pickets; and making crooked fascines to turn a corner; all of which expedients appear to me to be either useless or illjudged.

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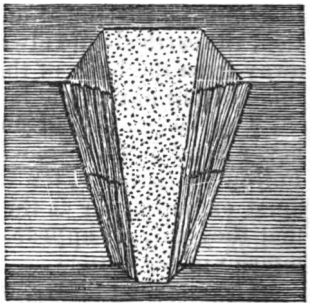
of the battery itself. Hence if they were intimately connected together, they would both suffer at the same time; and the continual repairs necessary for the cheeks would become more difficult.

Embrasures have sometimes been covered at top, by one or two courses of fascines stretched across the opening. Having made some batteries for practice in this manner, it occurred to us, that those covering courses might do more harm than good; as a shot striking one of them might derange the other courses of fascines at the top of the back of the merlon, with which the covering fascines must necessarily be connected.

Agreeably to the general rule for the slopes of the cheeks of embrasures, which has already been repeatedly stated, whilst the successive courses of fascines are made to stand vertically over each other in rear or nearly so; each succeeding course must be made to splay outwards, at the other end, or towards the front, about 6 inches more than the course immediately below it. This arrangement gives to the fascines used in the cheeks of an embrasure, the appearance of an open fan, as represented in the annexed figure, whilst it effects the object of gradually increasing the slope, from the neck to the mouth of the embrasure.



In reveting the interior slope of the parapet with fascines, they should be laid their whole length, without cutting them, except to suit the form of the back of the merlons, or occasionally to break joint. But in reveting the cheeks of embrasures, it is best to use two 9 feet fascines in each course, instead of one 18 feet fascine: and the vertical joints, thus formed in the middle of each cheek-revetment, should not be broken. The reason is, that from the peculiar action of the concussion of the air, occasioned by the firing of a cannon in an embrasure, as before stated, the front part of the fascine revetment of either of the cheeks is liable to very little injury from the said concussion, whereas, the rear of such a revetment is sure to be destroyed by it in a very short time. Hence it will be evident, that the repairs may be much facilitated, and accomplished with less waste of materials, by not connecting these two portions of the revetment.

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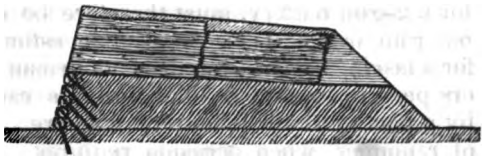
The annexed figure is the Profile of an elevated fascine gun battery, taken through the center of an embrasure, showing the solid in section, and one cheek of the embrasure, in elevation, in the latter of which, the unbroken vertical joint from the bottom upwards appears. The fascine work is not continued, so as to line the whole cheek, as this has been considered superfluous. The front part therefore is supposed to be a slope of earth.



In the standard profile, adopted by us, the sole of the embrasure is not parallel to the superior slope of the parapet, and consequently, the cheeks of our embrasures are not of equal height throughout. For this reason, five courses of fascines are used in the rear or highest part of the cheek-revetment, represented in the foregoing figure, but four courses only are used in the front part of it.

Here it may be observed, that the same rule should be followed in all fascine revetments, in which the work reveted is of unequal height.

Let the fascine work always be commenced from the bottom in regular courses, which need not be exactly horizontal, but may agree with the surface of the ground if inclined. At top, let the fascines be laid in steps, to suit the obliquity of the crest of the work, cutting them shorter for that purpose, if necessary. The irregular intervals at the end of each step, which are of a triangular form, may either be reveted with sods; or simply made good with rammed earth.

In pulling down any part of a fascine revetment, for the sake of repairing it, and not with a view to total demolition, it is best to introduce the points of several pickaxes at the same time, behind a portion of it, and to draw out the fascines by forcing them off from the heads of the pickets. The latter must then be driven quite home into the earth, that they may not stand in the way of the new fascines, that are to be used for the repair. The former operation must be done with great care, by several men prizing together with their pickaxes, and not by individual exertion, which will lead to the breakage of those tools, as was before mentioned.

When a working party of troops of the line are employed at a fascine Battery, the most intelligent men should be



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selected for builders, giving the preference to artificers. In reveting with 18 feet fascines, owing to the length and weight of each, four men are the smallest number, that can act together as builders: and this number although sufficient for a 2-gun battery, must therefore be employed, even in a one gun fascine battery. But in estimating the workmen for a fascine battery, you need not demand more than 2 builders per gun, as the regular builders can always be assisted by a part of those labourers, who are told off for the duty of ramming, when occasion requires it, without impeding the progress of the work in other respects.

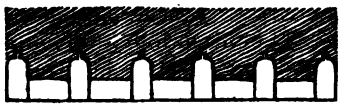
In constructing a fascine battery, each pair of builders should carry a maul and a hand-saw, which are the only tools necessary, besides the measuring implements, provided for the general service of the battery.

Each course of 9 inch fascines is compressed a little in building, so that one with another they average only about $8\frac{1}{2}$ inches in height, in the revetment of a fieldwork.

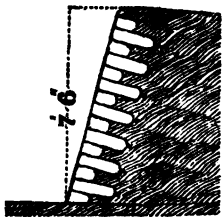
### 4. OF SAND BAG REVETMENTS FOR BATTERIES.

When sand bags are to be used for retaining the interior slope of the parapet of a battery, bricklayers or masons, or men of any other trade connected with building, such as carpenters, slaters, &c. should be selected for the builders; and such men are always to be found in Military working parties. The usual slope of one fourth of the height is proper. The bags must be laid alternately headers and stretchers, with the joints of successive courses broken, so as to have the appearance of Flemish Bond in brickwork. The neck of the bag, which is tied with a string, should always be laid inwards in the heading courses. Instead of placing each course horizontally, it is best to place them at right angles to the slope, as in a leaning revetment.

The annexed figures represent the plan and section of a portion of a sand bag revetment, built on the above principle.



Plan.

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In reveting an earthen work with sand bags, two builders must work together, who are supplied with sand bags by diggers, who also fill the bags, and carriers who hold them whilst being filled, and tie them, which must be done before they are quite full, otherwise they will not be flexible enough to accommodate themselves to the slopes, and to form good bond. In building with sand bags, the earth should be rammed well behind them, and the bags when laid should be flattened or beat into the proper level and slope, instead of leaving them round. Mallets or rammers may be used for this purpose, but spades or even shovels are preferable.

When there is a scarcity of artificers in a working party, one of the two men employed in building may be a labourer.

Bushel sand bags, the only ones now used in the British Service, should measure about 2 feet 8 inches, by 1 foot 4 inches, when empty and laid flat.

When quite full, one of these sand bags will hold a cubic foot of earth nearly, but in the way they are usually filled, it requires about 48 or 50 bags to one cubic yard (or 27 feet). The courses of a sand bag revetment average 6 inches high: and each pair of sand bags laid Flemish Bond, occupies 2½ feet in length, in the face of the revetment: hence 16 sand bags will build 10 superficial feet.

Two builders, provided that one of them be an expert workman, will lay about 70 bags, or build at the rate of about 44 superficial feet with ease, in an hour, if supplied with as many bags as they can use. But from the commencement of an elevated battery, until the parapet is more than half-finished; this number of builders are able to build twice as fast, as it is possible for the labourers to prepare the mass of earth, that is to be reveted. Hence, at the commencement of an elevated battery, I would tell off only 4 men per gun, for building, of whom 2 should build, one fill, and one carry: and as the builders will at times be obliged to stand still for want of bags, on account of their having so few assistants, they also must fill or carry themselves occasionally. By this arrangement, the builders will always be able to keep ahead of the labourers, even in the easiest soil.

After the embrasures shall be commenced, the 2 builders will not be able to keep up with the labourers, in very easy soil, without more assistance. At this period therefore 7 men per gun must be employed in building; namely, 2 build-



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ers, 2 fillers, and 3 carriers; the number of assistants according to this last arrangement, being sufficient to keep the 2 builders always actively employed, by supplying them with as many bags, as they can possibly use. At this period, notwithstanding that 2 builders, if fully supplied with bags, can keep considerably ahead of the labourers in very stiff soil, yet as the picking of the earth to fill the bags is more laborious, which may require a carrier or a builder occasionally to assist, in that operation, it is not worth while to make any alteration of the demand of builders or their assistants on that account, it being simpler to demand the same number for every description of soil.

Sand bags should be tarred, when they are about to be used, for the revetments of Field Works, which we know by experience will preserve them for months, whereas if they be laid, without previously undergoing this process, they are liable to rot in the ground, in wet weather in a few days. But I have been assured that tarring injures the cloth, and will even destroy it, if kept in store, for some years. If this assertion be correct, for which I cannot vouch from my own experience, it would of course be proper, not to tar sand bags, until they are wanted for immediate use; and not more in number, than are likely to be expended in the course of the siege or other operation, for which they may be required.

### 5. OF SOD REVETMENTS.

Sods cut on the spot in a rough manner may be occasionally used in the interior slopes or ends of the epaulments, or over the uppermost course of gabions or fascines, in the parapet of a battery, to make up a little extra height when required. But there are strong objections to the systematic use of regular sod work for offensive batteries, inasmuch as sods require a slope of one third, which is a disadvantage, and the construction of a neat and durable sod revetment, such as is proper for permanent works, or even for defensive field works, involves more time and labour, than any other kind of revetment without exception. A brick wall for example might be built about three times as quick.

* In 1825, for the sake of experiment, we exposed a number of sand bags made of sail cloth and of hessen to the weather, part of which were tarred, and part prepared by the process termed anti-milldewing, whilst the remainder were left with the cloth in its usual state as prepared for sale. At the end of 54 days of very wet weather the common and even the anti-mill-dewed sand bags were found to be perfectly rotten, whilst the tarred ones remained sound and serviceable.

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In regular sod work, sods of 8 inches wide and 16 inches long, laid alternately headers and stretchers, according to Flemish bond, with the grass undermost, are the best. Each course should be about 2½ inches high, so that about 5 sods will build 1 superficial foot of revetment. One superficial foot of good meadow land will not furnish on an average more than one such sod, making an allowance for waste.*

Bricklayers and masons, and next to them artificers of any other trade, connected with building, are the best men to employ in sod revetments. Wooden profiles, or battering plum rules, and lines, are necessary, as in regular brickwork. Small pins split out of pieces of deal, may be used to connect several courses together. Large knives are useful for trimming and paring the sods, in laying them.

## 6. OBSERVATIONS ON THE COMPARATIVE ADVANTAGES, OF THE VARIOUS REVETING MATERIALS FOR SIEGE BATTERIES.

The experience of this Establishment has proved that gabions, in two tiers, with a lower and an intermediate course of fascines, form the strongest and most durable revetment, for batteries; for after having been exposed to the weather for about a year, a gabion revetment of that description stood firm, whereas a fascine revetment executed in the same soil, and with equal care, bulged at top; and longitudinal fissures near and parallel to the interior crest of the parapet, took place. Moreover, fascines are only suited to stiff soils, which by ramming are enabled to retain good hold of the pickets. If the soil be loose, or the ramming neglected, a fascine revetment will be sure to fail.† We have also found, by experi-

* In cutting sods gardeners are generally provided with two tools, one a very small sharp instrument, in the shape of a semi-circle or crescent, with a handle like that of a spade, and worked by the foot, for cutting vertical lines on the grass, about 3 inches deep, to mark the length and width of the sods; the other a sharp and rather pointed sod spade, about 8 or 9 inches wide, with a long handle, and a cross bar at the end of it, by means of which it is pushed forward horizontally beneath the surface, without much stooping, and cuts and turns over the sods, in an easy and convenient manner. On an expedition, it would scarcely be worth while to take these tools, for the common spade ground sharp will answer the purpose, although not quite so conveniently. Sods were much used for the field works in the defence of Cadiz in 1811, and 1812.

† It is true that the defects of a fascine revetment may in some measure be remedied, even in loose soil, by introducing extra fascines as headers and angle ties: but one could scarcely make sure of this being always done with judgement and care, it being under ordinary circumstances a superfluous precaution.

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ment, that gabions are better than fascines, for reveting the cheeks of embrasures, as the latter are much sooner destroyed by the effect of the firing of the guns of the battery, and are not so easily replaced. At one time we had an idea, that gabions of a greater diameter might form a more substantial revetment, but on due trial, we found contrary to our expectation, that 2 feet gabions did not yield to larger ones in stability, and they are much more convenient in every other respect. It was before stated, that our standard gabions average 3 feet high in a revetment. An increase of that height would evidently be attended with great inconvenience.

We have sometimes reveted the whole of the interior slope of the parapet of a battery with fascines, using gabions for the cheeks of the embrasures only This arrangement makes a good revetment in soil suited for fascines.

Two gabions will very nearly build the same quantity of revetment as one 18 feet fascine. Hence it appears, that a considerable saving of materials results generally, from the use of gabions, instead of fascines, in all cases in which the former will answer equally well; for on a reference to the first part of this work, it will be seen, that the 2 gabions may be made with about half the quantity of brush-wood, that is necessary for 1 fascine.

Sand bags were much used in the British service, in the late wars,* but they are certainly very inferior to gabions, or even fascines, for the construction of Batteries; and they appear particularly ill suited for reveting the cheeks of embrasures. In other situations, they may be used at times to advantage, especially for the repairs of the irregular breaches, in parapets or traverses, occasioned by the bursting of shells.

In respect to the labour and time occupied in building, it was before observed, that in a gabion battery, no constant builders are required: in a fascine battery 2 builders per gun are necessary, and considerable care and skill are required to execute the work well. In a sand bag battery, 2 builders per gun with 2 assistants are required, making 4 men in all to begin with; and after the embrasures are commenced, the same number of builders require no less than 5 assistants, making 7 men in all. Hence the gabion revet-

* Probably from necessity, as was the case with me; for when I was first required to construct batteries against an enemy, I had never seen a fascine or a gabion made, and had no person under me, who even *knew* what such things *were*.

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ment is the most saving of labour, whilst the sand bag revetment involves a considerable waste of it.

### 7. OF THE UTILITY OF RAW HIDES FOR DIMINISHING THE INJURIOUS EFFECTS, PRODUCED BY THE FIRING OF THE GUNS IN A BATTERY, UPON THE CHEEKS OF THE EMBRASURES.

We have ascertained by experiment, that raw bullocks' hides will effectually secure the cheeks of common embrasures reveted with gabions, against the violent concussion of the air, or more properly speaking, against the effects of the elastic fluid generated by the repeated explosions of the gunpowder, in the firing of twenty-four pounders with full charges.* The largest hides should be selected for this purpose, and doubled longitudinally, with the hair inwards, the head part of the hide being to the rear, and the fold at bottom. The upper side of the hide thus folded, must be picketed down to the top of the merlon or upper part of the cheek of the embrasure, which it is to protect: whilst it must be secured in the same manner in rear, by pickets driven into the back of the gabion at the neck of the embrasure. In front it must likewise be picketed to the cheek of the embrasure, not only above but below. In other parts let it be loose at bottom. This is the simplest mode of attaching hides to the cheek of an embrasure; and requires no further precaution to render it effectual, than to use good pickets, judiciously driven, and to take care not to cut the holes through the hides, for receiving those pickets, any larger, than is absolutely necessary.

Another method was tried of forcing the hide to enter into the recesses between adjoining gabions by means of strong vertical pickets, confined at top by a horizontal pole, passing in front of the heads of all these, and picketed down to the earth in the line of gabions upon which this pole rested.†

* Captain Harry D. Jones, late Adjutant of this Establishment informed me, that the same expedient was found to be the only effectual means of preventing the stone merlons of the works of Cadiz, from being destroyed by the firing of heavy guns through the embrasures, in the defence of this Fortress in 1810, and 1811. This induced us to try the same expedient at Chatham, for the protection of the cheeks of the embrasures of gabion and fascine batteries, in the months of July and September 1829, after having previously ascertained, that only ten rounds fired from a medium 24 pounder rendered a fascine embrasure totally unserviceable, and severely injured a gabion one, when not so protected.

† This arrangement was suggested by Captain Wilson, who had charge of the experiments alluded to.

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Having prepared an embrasure, with one cheek secured in this last manner, and the other in the manner before described, we fired 50 rounds from a medium 24 pounder, with full charges of 8 lbs each, one half of which were shotted; and the gabions under the hides, were found quite perfect, and moistened a little. Two hides only were used, one on each side, which covered the three rear gabions of each cheek. The hides themselves appeared also to be very little injured, if at all, as the explosion merely blackened them; at the same time, that it moistened their surface.* Indeed there seemed every reason to believe, that they would have stood twice as much firing, without being materially injured.

Of the two methods used, the additional vertical pickets appeared to have a little the advantage in securing the hides, but to a degree barely perceptible. The fourth and fifth gabions on each side, not being covered by the hides at all were injured, but not to such a degree as to be unserviceable.† On a former occasion, on firing in a similar manner, through a gabion embrasure of the same description, the second pair of gabions on each side were destroyed, and the third pair next to them were much injured, by the firing of only ten rounds.

On service, there can never be any want of raw hides, which the cattle provided for the food of the besieging army would supply in abundance; and therefore I would recommend using two hides for each cheek, instead of one hide only, to which we limited ourselves in our experiments at Chatham, for the sake of economy. In using one hide only, the gabion at the neck of the embrasure need not be covered as it is not liable to injury from the firing. In using raw hides, care must be taken to avoid the unpleasant or perhaps pernicious effects, that might arise from their putrefaction; for which reason those, that are likely to be wanted for any length of time, should be well rubbed with salt on the inside, and afterwards sprinkled with it, and then doubled

* The explosion produced by the firing of a medium 24 pounder, through an embrasure, has no tendency to set the reveting materials of the cheeks on fire, although the smoke from the gun settles upon them in such a manner, that a hasty observer might suppose it to be produced from those materials themselves.

† The doubling of the hides appears absolutely necessary. For when the same experiment was tried before, with single ones, the hides themselves began to tear, and fragments of them were even blown away, after firing only 26 rounds; and it was the general opinion of the officers and men present, that 10 or 12 rounds more would have rendered them totally unserviceable, probably from the picket holes in a single hide being too weak.

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with the hair outwards, in which state, they should be allowed to remain for a day or two, before they are used. And as soon as symptoms of incipient putrefaction appeared in any of the hides used in a battery or other work, they should immediately be removed and buried.

Quick lime is also a preventive of putrefaction, but it injures the hide itself at the same time, which is not desirable previously to use.

## SECTION III.

### RULES FOR EXECUTING ELEVATED GUN BATTERIES.

1. OF THE SEVERAL EMPLOYMENTS OF THE LABOURERS, IN THE EXECUTION OF AN ELEVATED GUN BATTERY, AS DIVIDED INTO DIGGERS, SHOVELLERS, AND RAMMERS.

The dimensions of all the parts of an elevated gun battery, the method of tracing or marking it out on the ground, the reveting materials proper, and the best methods of building with them having been explained, we will now treat of the execution of the work, which depends in a great measure upon a good distribution of the men employed as labourers.

The earth for the parapet and epaulments of an elevated battery may either be obtained entirely from the ditches in front, or a portion of it may also be procured from the rear. We will first suppose the whole of it to be obtained from the front.

In this case, the men employed as labourers, act partly as diggers, partly as shovellers, and partly as rammers.

*First—Of the employment of the Diggers.* The diggers each carry a pickaxe and shovel, and are drawn up immediately in front or outside of the exterior berm line, but facing inwards or to the rear, that is towards the parapet of the battery. They excavate the earth close to the exterior berm line, loosening it with their pickaxes as much as may be necessary, and throwing it as far from them as they can without over-exertion.

Hence at the commencement of the work, they may throw it more than half-way across the base of the parapet,

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for on level ground, an able-bodied man inured to labour will throw 20 feet with ease, and he may even throw 15 feet to his own front, when standing on a trench 4 feet lower than the general level of the ground before him. But in proportion as the ditch of an elevated battery becomes wider, after having attained the full depth of 5 feet, the distance to which the diggers can throw their earth continually diminishes, so that by degrees they cannot conveniently throw it farther than the berm; and when the width of the ditch is gradually increased to more than 10 or 12 feet, it becomes impossible for them to throw it even so far as the berm, without over-exertion.

*Secondly—Of the employment of the Shovellers.* The duty of the shovellers is to throw the earth, furnished by the diggers, from the front of the parapet, or from the berm, more to the rear, so as to complete the interior slope. When fascines or sand bags are used, they must back each successive course with earth, as soon as it is laid by the builders. When a course of gabions is placed, they must fill them with all expedition, and then back them with earth, in all cases however allowing time for its being rammed properly. The only tools carried by these men are shovels.

*Thirdly—Of the employment of the Rammers.* These men are to ram the earth of the parapet and epaulments, as carefully as circumstances will permit, for the strength of field-works, especially when reveted with fascines, chiefly depends upon this process. The ramming of those parts of the solid and merlons, which are nearest to the reveting materials used, and generally speaking, the ramming of the earth towards the interior slope of the parapet and epaulments should be the most attended to. In a gabion battery, the rammers must ram the earth in the gabions, whilst being filled, taking care not to do it so violently as to strain them; and agreeably to the rule before-mentioned, they must also ram the earth with which the gabions are backed, with great care. They should not allow the loose earth in those parts above specified as requiring most attention, to accumulate anywhere to a greater height than about 6 inches, without ramming it well.

The men told off for this duty should always carry some spare tools, besides their rammers, as they may occasionally be required for other purposes.

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### 2. REMARKS ON THE RAMMING OF PARAPETS, &c.

If field-works were equally durable, or if their revetments could stand equally well, without being rammed; this process might be omitted altogether, not merely in parallels and approaches, but in siege batteries: for our recent experiments in firing at parapets with shot from a 24-pounder, with full charges, at the distance of 50 yards, gave us reason to believe, that loose earth is less injured by such firing, than more compact earth of the same quality. In the former, it was found that the shot buried themselves without scattering much of the earth. The latter they partially breached, knocking off numerous fragments, that flew about in all directions, and breaking up the parapet as far as they entered it, into masses, that did not immediately close again, as in loose earth: so that by degrees the penetration in the compact parapet was greater than in the looser one, and the total effect produced by an equal number of rounds much more injurious.* Ramming may therefore be omitted towards the outside of the parapet and epaulments, of a siege battery, being those portions of the work, which are the most exposed to the enemy's fire; but not towards the inside, where the enemy's shot cannot penetrate, and where this process of ramming is essential to the stability of the revetment or interior slopes.

In defensive field-works, on the contrary, such as are constructed during a campaign, to fortify a position of any importance, too much care and attention cannot be paid to the ramming of every part of the earth thrown up. Otherwise such works may be seriously injured if not destroyed by a continuance of bad weather. Indeed rammed earth is so exceedingly substantial and durable, that houses are frequently built of it, in mild climates.†

### 3. OF THE COMMENCEMENT OF AN ELEVATED GABION BATTERY.

In preparing to commence a gabion battery, all the workmen would be required to carry fascines or gabions

* An earthen butt thrown up loosely, and made 18 feet thick at top to represent a parapet, was fired at in this manner, first on the 23rd of May, a a few days after it was constructed, and afterwards on the 25th September, 1829. During this interval, the butt, which was composed of gravel and stiff clay had, by settling, after a good deal of rainy weather, acquired a consistency equal to that of rammed earth.

† As at Gibraltar, where it is known by the Spanish name of *Tapia*, and in the south of France, where it is termed *Pisé*.

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besides their tools. These materials would be deposited in the first instance in rear of the battery, not far from the interior base line.

The diggers should then be set to work immediately, in the ditch, whilst the rammers and shovellers, not being wanted at first in those capacities, should act as builders, laying the first course of fascines all along the interior base line of the parapet, and picketing them down; after preparing the foundation, in the manner described in the preceding section. They may also be directed to lay fascines, in a similar manner, along the interior base line of each epaulment, which by marking the foot of the interior slope in a conspicuous manner, will facilitate the commencement of the work; and although I do not recommend reveting any other part of the epaulments, these fascines may be allowed to remain.

The same men will also place the first course of gabions, along the interior base line of the parapet, when the ground is ready for them, and will fill and back them with earth supplied by the diggers, ramming it well as they proceed: and the like rule applies in respect to the remaining courses of fascines and gabions, used in a battery of this description, which should always be placed by the rammers and shovellers, without taking off the diggers, as the latter cannot be interrupted without materially delaying the completion of the battery.

### 4. OF THE NUMBER OF LABOURERS PER GUN, THAT ARE REQUIRED, FOR THE COMMENCEMENT OF THE PARAPET OF AN ELEVATED BATTERY IN EASY SOIL, AND OF THE TOTAL NUMBER OF WORKMEN NECESSARY, INCLUDING BUILDERS ALSO.

In making an elevated battery, in which, according to supposition, the whole of the earth is to be obtained from the ditch, it would be useless to carry any part of it in barrows, baskets, or bags, the distances being so very short, that from 2 to 3 and not exceeding 4 heaves of the shovel are sufficient, to distribute it all over the whole mass of parapet and epaulments that are to be formed. Hence it will be evident, that the progress of the work must depend entirely upon the quantity of earth, that can be supplied by the diggers in the ditch. But the number of men so employed must necessarily be limited by the space they have to work in: and as 18 feet is the length of parapet allotted for each gun, or common merlon, it follows that 4 diggers are the

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greatest number that can work to advantage in this space, which allows only 4½ feet per man. It was before observed, in treating of the execution of parallels and approaches, that 4 feet is almost the smallest space, in which a line of excavators can work at all; but no advantage is derived from thus crowding them; on the contrary.

Having assumed 4 men per gun as the proper detail of diggers, for the ditch of an elevated battery, when placed in one line or row, a query naturally occurs, whether the work may not be expedited, by employing 2 or even 3 rows of diggers, instead of one, which having been submitted to the test of careful and repeated experiment, at this establishment, it was found, contrary to expectation, that in easy soil, which requires very little picking, it was of no use whatever to have 2 rows of diggers.

The earth thrown up by 4 diggers in commencing a battery in easy soil, will furnish employment to 3 shovellers. The best proportion of rammers appears to be 2 per gun. More might be employed, but the above number is quite sufficient to ram the parapet, as much as is necessary, or desirable. Thus, the number of labourers per gun, required at the commencement of an elevated battery may be 9.

Hence in reference to the several modes of reveting siege batteries, that were explained in the preceding section, these 9 labourers, of whom a part act occasionally as builders, are all that are necessary for the commencement of a gabion battery, in easy soil.

To the above number of labourers, 2 builders per gun must be added in a fascine battery, making 11 workmen in all.

To the same number of labourers, 2 builders per gun, with 1 filler, and 1 carrier, to supply them with bags, must be added in a sand bag battery, making 13 workmen in all, that is at the commencement of the battery; for after the solid shall be completed, and the embrasures begun, 1 more filler and 2 more carriers must be added to the above, making 16 workmen in all.

Hence the gabion battery is the most economical, and the sand bag battery the most wasteful, of labour, as was before observed.

To explain the reason, that renders it useless to employ two rows of diggers in easy soil, it may be remarked, that should they both commence to work vigorously, the second or more advanced row will continually throw their earth against the men of the first row, the inconvenience of which

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being felt and complained of, will soon oblige both parties to relax, and thus neither of them will be able to exert more than half their powers, whilst every man is obliged to be on his guard, to avoid striking or being struck, by the shovelfulls of earth thrown forward from the second row. But experience has shown, that the more usual termination of this arrangement is, either that the first row of diggers will cease to excavate altogether, and become mere shovellers to the second or more advanced row; or that the whole will get intermingled in one line, in which case one half of the men must necessarily stand still from want of room, or wound each other with their tools, whilst the confusion in which they thus become involved, will, as in the former supposition, prevent them from exerting more than half their physical powers.

5. OF THE INCREASED NUMBER OF LABOURERS PER GUN, THAT MAY BE EMPLOYED, AFTER THE FIRST RELIEF OF WORKMEN, IN THE EXECUTION OF THE PARAPET OF AN ELEVATED BATTERY, IN EASY SOIL.

When the ditch of the battery shall have been excavated to the width of about 10 or 12 feet, it becomes difficult for the diggers to throw the earth upon the berm at one heave, and therefore nearly one half of them must necessarily cease to dig, and become mere shovellers to the other half, which for the reason before explained will lead to delay in the execution of the battery. At this period, therefore, an additional number of labourers may be employed to advantage in the ditch, to furnish shovellers, as well as diggers; and at the same period, the duty of the original shovellers above becomes more laborious, for they cannot now dispose of the whole of the earth thrown up to them from the ditch, at one heave of the shovel, as was the case at the commencement of the work; it being now thrown no farther than the berm, instead of half way across the parapet. Two rows of shovellers, in addition to the original distribution of labourers, may therefore now be employed, namely one row in the ditch and one row above. But the whole of the earth on the berm does not require to be thrown to any great distance. Part only must be thrown at two heaves of the shovel, to the rear or towards the interior revetment of the parapet. The remainder of it is thrown at one heave only, to complete the front of the parapet. Hence if we suppose three additional labourers to be employed in the ditch, to act as shovellers to the four original diggers, one additional

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shoveller above will be quite sufficient, making four in all, especially as one of the rammers may occasionally assist in that duty.

It is to be observed, that at the period when the additional labourers can thus be introduced with advantage, there is no necessity to insist upon the diggers and shovellers in the ditch, confining themselves to either of these occupations exclusively: nor to keep a fixed number of shovellers in the ditch or on the top, during the whole of the remainder of the work. On the contrary, one of the shovellers may occasionally be moved from the ditch to the berm, or vice versa, if either of those parties should appear to get on faster than the other: it being understood however, that the number of effective diggers in the ditch, should never be less than four.

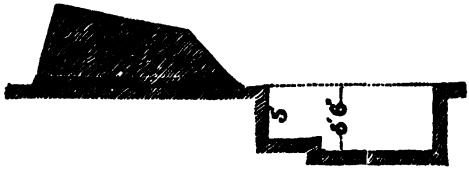
The ramming is so much easier work, than digging, that the men employed at the former, may occasionally change to the latter. And in a fascine battery, in particular, there not being constant employment at all times for two builders per gun, these men may at times assist the shovellers.

Upon the whole I do not recommend more than three or four extra labourers, all to act as shovellers, being employed at the second period of progress, in the construction of an elevated battery.

Thus the total number of workmen at the second relief may be 12 or 13, in the construction of an elevated gabion battery, 14 or 15 including the two builders, in the construction of an elevated fascine battery, and 19 or 20 in the construction of an elevated sand bag battery.

### 6. OF THE FORM, THAT MAY BE GIVEN TO THE DITCH OF AN ELEVATED BATTERY, AFTER IT ATTAINS THE WIDTH OF ABOUT FIFTEEN FEET.

It was before recommended, not to make the ditch deeper than 5 feet, in commencing an elevated battery, and this depth may be continued until the width of about 15 feet is obtained, at which period the diggers may increase the depth of the front part of the ditch to about 6½ feet, leaving a step of about 5 feet wide, immediately below the exterior berm line. During this process, the diggers from the front of the ditch will

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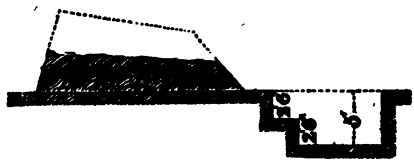
throw the earth upon the step, that has been described, whilst the shovellers standing on the above step will throw it upon the berm. The annexed figure is the section of the battery at this stage of progress.

This arrangement diminishes the labour of the men in the ditch, towards the close of the work, as a ditch of the uniform depth of 5 feet throughout would require to be excavated to the inconvenient width of more than 24 feet, before the parapet could be completed.

Having here introduced the subject of steps, I shall remark, that in commencing an elevated battery in loose soil, which is generally but not always implied by easy soil,* care must be taken, not to undermine the exterior slope of the parapet. In such soil, therefore instead of digging to the whole depth of 5 feet at once, this depth may be gained, by leaving a slope half way in addition to the berm, as shown in the annexed figure, which represents a battery in progress, supposed to have been commenced according to this method.



Or without resorting to this expedient, as a part of the earth in the ditch must always be moved more than once, if the perpendicular scarp of 5 feet seems in danger of falling, let it be secured by adding so much loose earth to the base of it, as will convert it into a slope. These arrangements are best left to the judgment of the executive engineer on the spot.

### 7. OF THE NUMBER OF LABOURERS PER GUN THAT MAY BE EMPLOYED, IN COMMENCING THE PARAPET OF AN ELEVATED BATTERY, IN DIFFICULT SOIL; AND OF THE TOTAL NUMBER OF WORKMEN NECESSARY, INCLUDING BUILDERS ALSO.

When the soil, in which an elevated battery is to be constructed, is so very hard, that the picking becomes the most laborious part of the work, a second row of diggers

* Some of the soil within Chatham Lines, composed of fine sand cemented by clay, is so easily cut, that it scarcely requires the use of the pickaxe, and is at the same time so tenacious, that it will stand when scarped perpendicularly, to a much greater depth than is necessary for the ditch of a battery.

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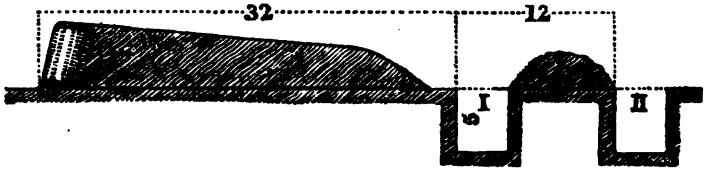
in the ditch, may then be employed to advantage, at the commencement of the work, provided that the following precautions be taken.

The first row of diggers will commence the ditch, by excavating a trench about 5 feet wide, close to the exterior berm line, and they will sink to the full depth of 5 feet, before they attempt to widen it, throwing the earth obtained upon the parapet or berm, according to rule. Four men should always be employed in the first row of diggers.

The second row of diggers, who need not exceed three in number, will commence a similar trench, at the distance of 12 feet from the former, for which purpose, besides the ordinary tracing necessary in all elevated batteries, an additional line must be marked on the ground, in front of and parallel to the exterior berm line, at the distance of 12 feet. This line must be equal to the interior base line of the parapet in length, and must terminate perpendicularly, opposite to the extremities of the said base line, without extending in front of the shoulder or shoulders of the battery.

The second row of diggers will excavate from this new line outwards, or towards the front of the battery. And thus there will be a tongue or level space between these two trenches, upon which the diggers of the second row are to deposit their earth, instead of attempting to throw it over. The annexed figure represents this arrangement, being the section of an elevated gabion battery in progress. The




Roman numerals I and II show the trenches of the first and second rows of diggers, whilst the intermediate space is the tongue, for the reception of the earth thrown up by the men of the second row.

It is evident, that the two trenches (I and II) ought to be connected somewhere, for the sake of a communication, on relieving the men in the ditch, whilst the battery is in progress. These communications or passages, may be made opposite to the extremities of the face of the battery, just where the roundings of the shoulders commence. A digger of the second row may be employed in each.



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The greatest care is necessary, to inforce the strict execution of the above arrangement, by preventing the men of the second row from throwing their earth over the tongue, into the trench of the first row of diggers. If this be allowed, the exertions of the first row of diggers will immediately be paralyzed, as they will become mere shovellers to the other party, and do nothing more. The officer superintending must therefore not content himself, with giving the strictest orders on this head. He must at proper intervals, personally see that they are obeyed. In short, he cannot be too vigilant, in exerting himself to prevent even the smallest or slightest deviation from this arrangement, from the commencement of the work, until it becomes proper to cut away the tongue, at which period, the battery will be about half-finished.

When the mass of earth on the tongue becomes inconveniently large, the first row of diggers will be directed to clear it away, by throwing it on the parapet, for which purpose, they will from time to time suspend their own excavation.

As soon as the trench of the first row of diggers shall have attained the full depth of 5 feet, and the same width, the battery being at this time about half-finished, as I observed before, both parties will be directed to cut away the tongue in concert; and at this period, it ceases to be necessary, to prevent the men of the second row from throwing their earth over the tongue as at first, or to prevent the men of the first row from acting partly as shovellers to the others.

It is to be observed, that a second row of diggers in the ditch does not furnish more work for the shovellers and rammers on the parapet, in working in stiff soil, than if there were one row of diggers only, which supposes easy soil Hence even in the stiffest possible soil, 12 men per gun, namely 7 diggers in two rows, 3 shovellers, and 2 rammers, are the greatest number of labourers, that can be employed to advantage, in the execution of an elevated gun battery; that is, provided the whole of the earth is to be obtained from the ditches in front, according to supposition.

To the above labourers, who compose the whole of the workmen necessary, in a gabion battery; 2 builders must be added in a fascine battery, making 14 workmen per gun in all: but to the same number of labourers, 2 builders and 2 assistants per gun, must be added in a sand bag battery, making 16 workmen per gun; and after the solid shall be

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completed, 3 more assistant builders may be added, making at that period 19 workmen per gun in all. The same remark therefore, applies in all cases, to these three sorts of revetments, the gabion battery being the most economical, and the sand bag battery, the most wasteful of labour.

After the tongue is completely cut away, the general depth of the ditch may be increased to 6½ feet, and the battery may be finished, according to the rule explained in the foregoing article.

During the whole of this latter period of the work, it is unnecessary to give any precise directions respecting the distribution or employment of the men in the ditch; for after the tongue is cut away, they have so much room to work in, that if they be well-disposed diligent men, they will be sure to arrange themselves in the most advantageous manner.

REMARK. In concluding this article, it may be remarked, that the same simple rule holds good, not only in the construction of batteries, but of field-works generally. If no more men be employed on the same spot, than can work to advantage, little or no superintendence is necessary, after the work is fairly commenced; for the men find their proper places, as it were instinctively, and having ample room to exert their strength, without incommoding one another, no part of their labour is wasted or misapplied.

8. THAT THE NUMBER OF LABOURERS PER GUN NEED NOT BE INCREASED, AFTER THE FIRST RELIEF, IN THE EXECUTION OF AN ELEVATED BATTERY IN DIFFICULT SOIL.

It having been proved by repeated experiments, that more than 4 diggers cannot work to advantage, in one line or row, within the space of 18 feet, and that the earth furnished by 2 rows of diggers, if employed together, cannot be thrown upon the parapet, at the same time; it follows, that the only use of a second row of diggers, in commencing an elevated battery in difficult soil, is to loosen the earth of the front part of the ditch, and to convert the stiff soil there, as it were into easy soil; which will facilitate the execution of the latter part of the work, at the time, when by the increase of the original excavation, it becomes proper that the 4 diggers of the first row shall have the assistance of shovellers also placed in the ditch; they themselves being unable, without such aid, to throw their earth at one heave, upon the berm, as at the commencement of the work. At



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this period, therefore, the 2 original rows of diggers in the ditch are converted into one row of diggers, and one row of shovellers; and to execute the work properly, according to this new arrangement, no more men are required, and no more men can work to advantage, than were employed at the commencement of the battery; for if an extra row of shovellers were introduced, in addition to the 2 original rows of diggers, and if the second row of diggers were once more thrown out in advance, the parapet would be finished, before any part of the new earth, loosened by these advanced diggers, could be disposed of.

In soil of an intermediate quality, between the easiest, and stiffest kinds, not coming under the denomination of rock, that are to be found in nature, an intermediate number of labourers between 9 and 12 per gun, may be employed in the first relief of workmen, or at the commencement of an elevated battery: but in all the other reliefs, the latter number may be demanded for every kind of soil, without exception,

### 9. OF THE NUMBER OF WORKMEN REQUIRED FOR EACH EPAULMENT, IN THE EXECUTION OF AN ELEVATED BATTERY.

When the flank of a battery is terminated, without an epaulment, there is no shoulder on that side: but wherever there is an epaulment, a shoulder also is necessarily implied. Let it therefore be understood, that in naming the epaulment of a battery, singly, the adjoining shoulder is also supposed to be included, unless it be specified to the contrary. This rule is always followed, in estimating the number of workmen for a battery.

When the epaulment of a battery is laid out at a moderately obtuse angle, or at a splay not exceeding 1 foot in 4, which taking all things into consideration, appears to be the most advantageous arrangement, and when it does not exceed the ordinary length of 25 feet at the base, and the ordinary thickness of 12 feet at top; the mass of earth required for the epaulment itself, is nearly equal to that which is required for the adjacent shoulder, and each of these two masses is nearly equal to a one-gun portion of the parapet or face of the battery. Hence in estimating the number of labourers, necessary for the epaulment of a battery, which as I said before, is also supposed to include the adjoining shoulder, when nothing to the contrary is specified; let it be exactly double

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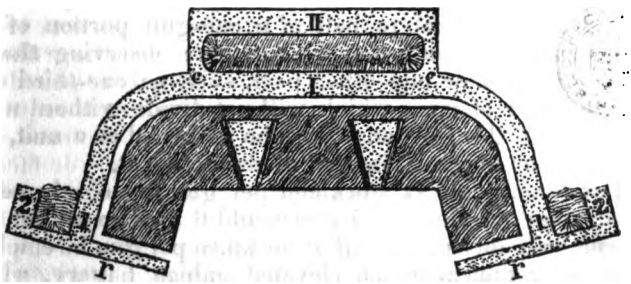
the proportion, fixed upon for a one-gun portion of the parapet of the same battery: and let one-half of the number thus demanded, be employed on the epaulment itself, whilst the other half are employed on the shoulder.

As the diggers in the ditch of the shoulder, and of the adjacent part of the epaulment, have a tendency to throw their earth inwards, towards the same common center, care must be taken to distribute it properly, instead of allowing it to accumulate in a heap, at this point. Hence particular attention must be paid to the superintendence, of the workmen, at and near to the shoulder, causing both diggers and shovellers to throw their earth obliquely, when required.

When the soil is so exceedingly hard, that more than 4 diggers per gun, and consequently more than 8 per epaulment, are demanded, it is not necessary to employ all the extra diggers of the epaulment and shoulder in a second row, like those of the parapet. For in consequence of the diverging form of the shoulder, the external arc of which, as described in the tracing of the battery, exceeds 40 feet in length, there is ample room in the ditch to admit of 8 or even 9 diggers, working abreast of each other, without being crowded: and in the ditch of the epaulment, there is ample room for 5 diggers in line, and 1 more may be employed in excavating the trench for the small ramp, to communicate between the ditch and the interior of the battery, the earth from which trench is also thrown upon the epaulment.

Hence in excavating the ditches of the shoulder of a battery, the diggers are always arranged in one row; and in excavating that of the epaulment, it can never be necessary to throw more than one or two men at the utmost, out of the first line of diggers.

The annexed figure represents the plan of an elevated two-gun battery, with two epaulments, in progress, supposed

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to be executed in stiff soil. The Roman numeral letters I, and II represent respectively the trenches executed by the first and second rows of diggers in the ditch of the face of the battery. The communications between those two trenches, are represented by the letters c, c; between which trenches and communications, the tongue is insulated, as shown in the figure. Opposite to each of the shoulders, and to a great part of the epaulment, there is only one trench (1 1) shown, being the commencement of the ditches of those portions of the battery, by one row of diggers only. At the extreme end of each epaulment, the ramp, r, and a second portion of trench, 2, give employment to 2 diggers, who are thus thrown out of the general line of the diggers employed in the ditches of the epaulments. In this figure, the berm of the parapet and epaulments is also distinctly shown; as well as the small tongue, which intervenes between the first and second trenches (1 and 2) of the ditch of each epaulment. The earth thrown up is shaded dark: the ditches or trenches are dotted: the intermediate berms are left blank.

As the epaulments are not reveted interiorly, no builders are necessary for the portions of a battery, which we are now treating of: but if we had still followed that system, which prevailed in the first years of the establishment, it would be necessary to add for each epaulment, as many builders, as for a one-gun portion of the parapet. The shoulders in either case require none.

### 10. OF THE NUMBER OF MEN REQUIRED FOR THE EXTREME HALF MERLON OF AN ELEVATED BATTERY, WHEN FINISHED WITHOUT AN EPAULMENT.

It was explained, that the half merlon of an elevated battery must be made about 11 feet longer than usual, on the interior base line, when proposed to be finished without an epaulment. The extra work thus occasioned, may be considered nearly equal to half of a one-gun portion of the battery, and may be estimated as such; observing that in taking one-half or any other part, such as one-third of a given number of men, which will not divide without a remainder, let the fractional part be reckoned as a unit, and added to the quotient, instead of deducting it.

For example, if 12 workmen per gun be employed in commencing an elevated battery, add 6 men extra, for the extreme half merlon; but if 9 workmen per gun be employed, as in commencing an elevated gabion battery, which

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number cannot divide by 2 without a remainder, add 5 men extra for the extreme half merlon, in preference to 3.

### 11. OF THE NUMBER OF EXTRA WORKMEN REQUIRED, FOR THE ADDITIONAL PORTION OF PARAPET, OCCASIONED BY EACH TRAVERSE, IN THE CONSTRUCTION OF AN ELEVATED BATTERY.

The extra portion of parapet, occasioned by a splinter proof traverse, not exceeding from 4 to 6 feet at the base, will require 1 extra digger in the ditch, or 2 extra diggers, if there be 2 rows, together with 1 extra shoveller, and 1 extra rammer, making 3 or 4 extra men, all labourers; for it is scarcely worth while to employ any extra builders, for so small an addition to the revetment, as such a traverse would occasion.

But if the traverse should be a very substantial one, measuring from 8 to 10 feet at the base, or upwards, the additional parapet, occasioned by it, may become equal to one-half of a one-gun portion of the battery, or even greater: and the detail of extra labourers necessary, may be regulated in the like proportion, never employing in one row, or in each of the two rows of diggers, more men than can work to advantage in the extra space. The extra shovellers, as well as the extra rammers, may generally be somewhat fewer, than the extra diggers of the first row. In respect to extra builders, it seems scarcely necessary to employ any, unless the additional parapet shall exceed 10 feet in length, which can only be occasioned by a traverse of a much more substantial description, than is likely to be required, in any of the first batteries, in a siege.

### 12. OF THE METHOD OF SETTING THE MEN TO WORK, IN THE EXECUTION OF AN ELEVATED BATTERY.

The men intended for the construction of the battery, must be divided into as many parties, as there are guns, traverses, and epaulments. The men told off for the traverses in the first instance, are for the formation of the additional portion of parapet, thereby occasioned; not to make the traverse itself. When one extremity of the battery has no epaulments, a party is told off for the extreme half merlon, in addition to the regular party for the extreme gun, on that side.

This distribution being made, and each party being placed under the command of a non-commissioned officer, and

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provided with proper tools and implements, the whole are marched down to the ground, previously marked out for the proposed battery, where they are made to take post in regular order. The parties for the guns, are each drawn up opposite to their respective embrasure pickets, the parties for the traverses opposite to the center of each great merlon, between two gun parties. The party for the extreme half merlon, if any, will be drawn up at the end of all, on that flank, where there is no epaulment. In like manner, the party for each epaulment, will take post opposite to the interior base line of that work: this party being from the first sub-divided into two sections, one of which is to be employed about the shoulder, as was explained in article 9. They will then be made to extend themselves along the whole line of work laid out, the diggers in the ditch, in one or two rows, according to circumstances, the shovellers and rammers in rear of the diggers, the latter being nearest to the interior base line of the parapet or epaulment, and the builders, if any, in rear of the said line.

To facilitate this arrangement, it is most convenient to draw up the men of each party in column, and to halt them in line of columns, immediately in rear of the battery, till all the non-commissioned officers shall have ascertained the proper places for their respective parties, after which, they will march them there, and extend them according to rule. The order of the small column, or party for one-gun is as follows.

The diggers are to be at the head, in one rank, or in two, according as one or two rows are to be employed in the ditch; and when in two ranks, the diggers of the second row will be in front. Immediately behind the diggers are the shovellers, and next the rammers, each in one rank. Lastly the builders, if any, who, in a fascine battery will form the rear of the whole; but in a sand bag battery, the carriers will form in one rank behind the builders, and the fillers in one rank in rear of the carriers.

The following diagram represents the arrangement for commencing a two-gun portion of a gabion battery, in which no builders are employed, but under the supposition of the soil being stiff, two rows of diggers are necessary.

The position and employment of each digger, shoveller, and rammer, are shown by the letters *d*, *s*, and *r*, being the initials of the words, that denote their respective employments. The parallel upright lines, mark the frontage, or

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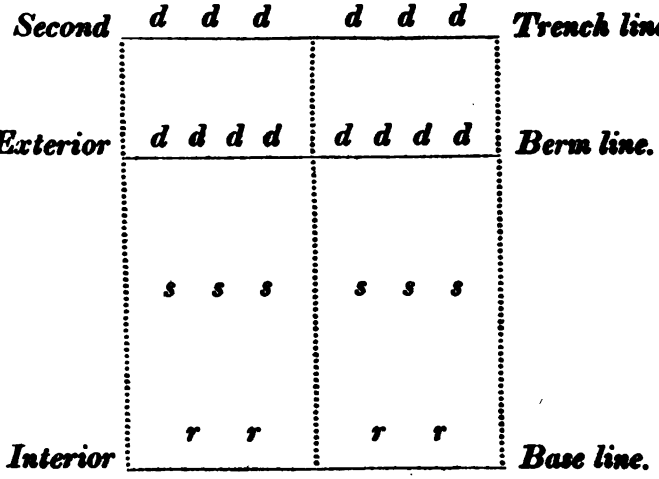
space of 18 feet, allowed for each of the two guns. At the bottom of the diagram, the positions of the two original columns of workmen, as halted in rear of the interior base line of the parapet, previously to their extension, are also represented.

*POSITION OF THE WORKMEN IN COMMENCING AN ELEVATED GABION BATTERY IN DIFFICULT SOIL.*




| | |
|---|---|
| *ddd* | *ddd* |
| *dddd* | *dddd* |
| *sss* | *sss* |
| *rr* | *rr* |

In another diagram of a similar description, given on the following page, the arrangement of the workmen for commencing a two-gun portion of an elevated sand bag battery is represented, the additional letters *c* and *f* denoting the carriers and fillers of sand bags, the latter of whom are supposed to dig their trench for that purpose, at the usual distance of about 30 or 40 feet in rear of the interior base line of the parapet.

Whilst inspecting this diagram, you will recollect, that three more men per gun, than are represented therein, will be required to act as carriers and fillers, after the embrasures shall be commenced.

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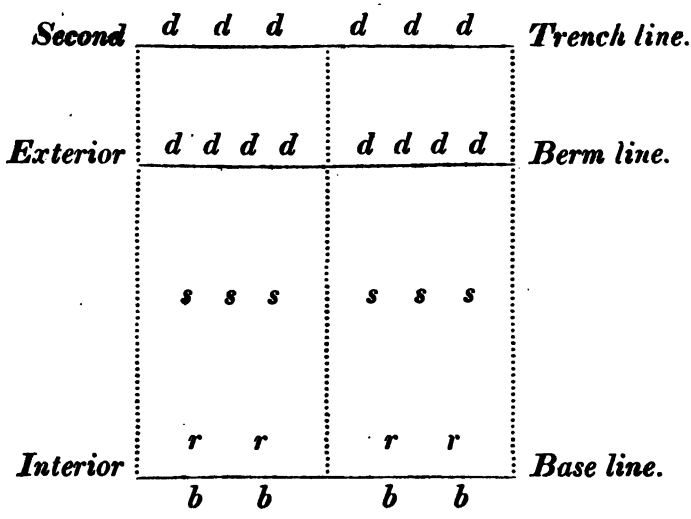
*POSITION OF THE WORKMEN IN COMMENCING AN ELEVATED SAND BAG BATTERY, IN DIFFICULT SOIL.*

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In a gabion or sand bag battery, every man is confined to his own one-gun portion of the work; but in a fascine battery, the builders of two or three guns must work together, over the whole space belonging to those guns, and not for separate portions of it. Hence whilst the labourers of each one-gun portion of a fascine battery are extended and set to work, by the non-commissioned officers of guns, the builders are collected under distinct non-commissioned officers, and told off, in squads, for two-gun, or three-gun portions of the work, and an intelligent private is appointed the head of every such squad.

13. STATEMENT OF THE QUANTITY OF EARTH, NECESSARY FOR COMPLETING THE PARAPET AND EPAULMENTS OF AN ELEVATED GUN BATTERY.

*First—For a regular one-gun portion of the Parapet.* The content of the solid, or lower part of a one-gun portion of the parapet of an elevated gun battery, according to the profile before explained, amounts to very nearly 51½ cubic yards, but as this estimate includes also the reveting materials used; 50 cubic yards of excavation in the ditch, generally may be assumed, as furnishing earth enough for this part of the battery, more especially if the parapet be but moderately rammed.

From the rules before given, for the form of the embrasure of a one-gun battery, which leave the slopes of the cheeks towards the mouth, variable to a certain degree, as well as from the nature of the reveting materials used, it may be expected, that the solid content of the several merlons of a gun battery is liable to vary a little, even if all the embrasures be laid out by the same rule. I conceive, however, that about 29 or 30 cubic yards, including the reveting materials, may be assumed, as a fair estimate of the solid contents of the upper part of a one-gun portion of an elevated battery. And it is probable, that from 27 to 28 cubic yards of excavation in the ditch, will generally supply earth enough for this part of the parapet.

The above estimates of the quantities of excavation necessary agree very nearly with the results of our practice at Chatham, in which we usually measured the ditch at two several periods, first on the completion of the solid, and afterwards when the whole parapet was finished.

Sometimes greater excavations than the above were required, especially in the first years of the establishment,

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when we used to take much more pains in the ramming of our parapets, than we have since considered necessary. For we have repeatedly found, that earth may be compressed by ramming into a smaller space, than it occupied on the original ground; which curious fact, was I believe first noticed at this establishment.

Here it may also be remarked, that earthen works thrown up rather loosely, and without much ramming, settle by degrees, and lose somewhat of their height, which is very conspicuous in all our old batteries.

*Secondly.—Of the quantity of earth, in the additional Parapet occasioned by each Traverse.*

The above estimate of about 50 cubic yards for the solid, and 28 for the upper part or merlon of an elevated gun battery, making 78 cubic yards in all, which being divided amongst 4 men is at the rate of 19½ cubic yards in all per man, applies only to a regular one-gun portion of the parapet, having an embrasure between two half-merlons. In respect to the extra portions of parapet occasioned by each traverse, these being all solid involve a greater quantity of labour to complete them: for in the profile of each of these portions there are 153 superficial feet or 17 superficial yards. Hence in every foot of additional parapet, there are 5⅔ cubic yards of earth to be provided for.

*Thirdly.—Of the quantity of earth required for the Epaulments.*

The mass of earth required for one epaulment, including its shoulder, and consequently the excavation necessary for forming it, differ so little from those of a two-gun portion of an elevated battery, that they may be estimated as being equal.

## 14. OF THE TIME NECESSARY FOR THE CONSTRUCTION OF AN ELEVATED GUN BATTERY.

*First.—To complete a Parapet of the standard dimensions, without Traverses, and consequently without any great Merlons.*

In the preceding article, it was explained, that 50 cubic yards of earth per gun, are required for the solid, which being divided amongst 4 diggers, is at the rate of 12½ cubic yards per man, which in easy soil, that requires little or no picking, may be finished by an able-bodied man inured to labour in 7 hours. To complete the two half-merlons, or upper part of the parapet, it was stated, that about 28 cubic

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yards more of excavation are necessary, which being in like manner, divided amongst 4 diggers, is at the rate of 7 yards per man, which in the same description of soil, may be finished in 4 hours. Accordingly it may be assumed, that by keeping 4 diggers constantly employed in the ditch, an elevated battery may be finished in easy soil, which requires little or no picking, in 11 hours of actual labour.

This agrees with the result of the last experimental battery, constructed by us at Chatham, in which 4 men only were employed in the ditch, from the beginning to the conclusion of the work, so that after the width of the ditch exceeded 10 or 12 feet, a part of these men were taken off from digging to act as shovellers. The solid was by this arrangement completed in 7½ hours; and the remainder of the battery was finished in 6½ hours more, making 14 hours of actual labour in all. After one third part of the excavation of the ditch was executed, three extra men should have been sent into it as shovellers, according to the rule given in article 5, in order to prevent the original diggers from being obliged to act in that capacity. If this had been done, it was the opinion of all the Officers, who were present at the construction of this battery, that it might have been finished at least three hours sooner. It was stated in the first part of this work, in treating of the execution of parallels and approaches, that an excavation in very hard stiff soil, such as does not absolutely come under the definition of rock, may take about double the time, that is necessary for an equal quantity of excavation in easy soil, that requires little or no picking. This also agrees with our last practice in battery building. Our elevated gun batteries were repeatedly finished in 22 hours in the hardest and most difficult soil, that was to be met with in this neighbourhood, consisting of a concretion of flint gravel, cemented by stiff clay. Two rows of diggers were in all cases employed, 4 of whom were placed in the first row, as directed in article 7 of this section; but in one case only 2 men, instead of the more usual number of 3, were employed in the second row.

To conclude, it may be assumed, that the time necessary for completing an elevated gun battery, agreeably to the rules for the distribution and employment of the workmen, laid down in the preceding articles of this section, will vary according to the nature of the soil from 11 to 22 hours, the former time applying to the easiest, and the latter to the most difficult kinds of soils, rock not included, that are to be met with in nature.

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*Secondly—Of the Time necessary to complete a Parapet with Traverses in rear of it, and consequently having great Merlons.*

The foregoing estimate as to time applied to a parapet without traverses, in which the quantity of earth required for each regular merlon or one-gun portion is about 78 cubic yards. If we suppose a traverse, behind any of the merlons, having 5 feet of base, and consequently adding 5 feet additional parapet, the space from center to center of the collateral embrasures will be increased from 18 to 23 feet; 5 diggers will be employed in the ditch instead of 4, and the cubic content of this great merlon will be increased to more than 105 cubic yards; and for a traverse having 6 feet of base, the cubic content of the said merlon would be increased to about 111 cubic yards, after making some deduction for the reveting materials.* Hence the quantity of excavation for each of the 5 diggers in the ditch of the great merlon, will be at the rate of about 21 cubic yards tor a 5 feet traverse, and at the rate of about 22½ cubic yards for a 6 feet traverse, instead of the usual rate of 19½ cubic yards per man, which applies to a common merlon.

This increase of labour will of course produce a certain increase of time, but not quite in the above proportions, for as soon as the common merlons, on each side of the great merlon are finished, the diggers employed in the ditches of those two collateral merlons, must still continue to dig earth there, which they and their shovellers must be directed to throw obliquely, towards or upon the great merlon; which will greatly accelerate the completion of that portion of the battery, without at all impeding the exertions of the workmen originally allotted for it.

Under this consideration, if we suppose splinter proof traverses, having 5, or even 6 feet of base, to be introduced between every two guns in an elevated gun battery, it may be assumed that the great merlons thereby occasioned, will not retard the completion of the battery, by much more than half an hour in easy soil, and one hour in very stiff soil.

* By the rule given in the preceding article, multiply 5⅔ by 5, and the extra labour occasioned by 5 feet additional parapet, will be measured by 28⅓ cubic yards, being the product of those two numbers. This added to 78 gives 106⅓ cubic yards for the whole quantity of excavation required to form the great merlon, behind which the supposed traverse is to be situated from which some abatement ought to be made for reveting materials. In like manner, 5⅔ multiplied by 6, and the product added to 78, will yield a result of 112 cubic yards for the quantity of excavation, required for a great merlon, having a traverse with 6 feet of base, behind it.

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Hence an elevated gun battery with such traverses may be finished in about 11½ hours in easy soil, and in about 23 hours in difficult soil.

*Thirdly.—Of the Time necessary to complete the Epaulments.*

In respect to the epaulments of an elevated battery including their shoulders, these may always be finished rather sooner than the parapet, supposing equal diligence on the part of the men employed. For the 8 diggers allotted to the ditch of one epaulment and its shoulder, in easy soil, being spread out along a much greater space, than those of the parapet, form a much longer excavation, but a narrower one. This latter circumstance makes their work easier, as they never have to throw their earth so far, in order to reach the berm, and in easy soil, most of the extra men placed in the ditch, after the first relief have room to act as effective diggers, and are not wanted as shovellers, until the battery shall be nearly finished. In stiff soil, this advantage, commencing even with the first reliefs of workmen, is of still greater value towards the advancement of the work. Indeed in any soil, it is of so much importance, that I conceive it possible, under all circumstances, to finish the epaulment of an elevated battery, in little more than half the time required for the parapet, by employing a greater proportion of labourers in the former; but such an arrangement would evidently be of no use.

I shall conclude by observing, that the practice of this establishment has confirmed the above observations, since the epaulments of our experimental batteries, have generally been finished, at least an hour sooner than the parapets of the same, both being manned by the proportional numbers of workmen, recommended in articles 8 and 9 of this section.

### 15. OF THE MODE OF RELIEVING THE WORKING PARTIES, EMPLOYED IN THE CONSTRUCTION OF AN ELEVATED BATTERY, SUPPOSING IT TO BE ONE OF THE FIRST BATTERIES IN A SIEGE.

In the first part of this work, in treating of the opening of the first parallel, and of the first operations of a siege generally, it was recommended that three reliefs or changes of workmen should take place during the 24 hours: but that to supply these three, there should be four reliefs of

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workmen in all; to prevent the same men from coming always on duty at the same hours of the night, and also in order that the troops who supply these working-parties may not be harrassed too much. The same rule extends to the mode of relieving the workmen employed on the first batteries, the construction of which usually constitutes the second operation of a siege, being generally undertaken after the completion of the first parallel and of the approaches connected with it, although sometimes postponed, until the second parallel is finished. But whilst in both cases, there should be the same number of reliefs of workmen in all, and the same number of changes during the 24 hours; it appears to me, that the following difference of arrangement is proper, in respect to the workmen employed in the first parallel, and those afterwards employed in the first batteries: namely, that the former should have one relief only, out of the three, employed by night, and the two others by day; whereas, the latter should have two reliefs out of the three, employed by night, and the remaining one by day.

The arrangement recommended, of not sending the second relief of workmen into the first parallel, until after daylight, was with a view to prevent the risk, or rather the certainty of confusion, that might arise, from attempting to extend a number of men over a very great space of ground in the dark. At the same time, the risk from the enemy's fire is not increased by waiting till daylight, for the labour of the first relief will have produced sufficient cover, to screen the workmen from the enemy's view, who will seldom waste the fire of his artillery upon a parallel, by throwing it away upon men whom he cannot see, and whom he knows to be working in such very extended order, that few casualties are likely to be produced thereby.

In respect to the first batteries, the case is very different, The workmen are concentrated on so small a spot of ground, that if a proper distribution be made, on the principles developed in the former articles of this section, there is little or no risk of confusion even in the dark. The second relief of workmen should therefore always take place on the same night, in which the battery is commenced, which in nights of 12 hours, might be at midnight. This is of more importance, as the circumstance before noticed of the men being concentrated on a small space, renders them more liable to casualties from the fire of the enemy's artillery; to the full

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view of which the greater part of the workmen employed on a battery in progress become exposed, immediately after daylight, none but the diggers, in the ditch of the parapet, being well covered. Hence little progress can be made towards the completion of a battery in the day time, if the besieged should think fit to keep up a brisk fire of artillery upon it; which is usually done, it being considered an object of considerable importance to them, to impede and retard the construction of the first batteries in a siege, as much as possible.

In easy soil, two reliefs of workmen, one commencing after dusk, the other at midnight, as before recommended, might finish two thirds of an elevated battery before morning. Strictly speaking, there is time in a night of 12 hours to do the whole; but as untoward circumstances causing delay, may occur on service; and as the soldiers employed on the working parties may not always be sufficiently inured to labour beforehand, or may have had their strength impaired by previous fatigues; I do not recommend calling upon the two first reliefs, to do more than to complete the solid, this first night.

### 16. OF THE TASK THAT MAY BE ALLOTTED TO THE FIRST RELIEF OF WORKMEN, IN EXECUTING AN ELEVATED BATTERY IN EASY SOIL.

*First.—In respect to the Parapet.* The task of the first relief of workmen employed on the parapet of an elevated battery in easy soil, may be to finish one-half of the solid, or a little more: but as it may be considered advisable, not to carry up the parapet of a siege battery regularly, and of uniform height throughout, as is usually done in our practice at this establishment, but to make an effort to raise the interior crest of it to the height of the sill of the embrasure, as soon as possible: in this case it would be difficult to determine the proper task by the state of the parapet. I would therefore recommend in all cases, that the task of the men of the first relief, shall be determined by assigning a certain quantity of excavation to the 4 diggers in the ditch, which may be at the rate of 6¼ cubic yards per man. This may be determined by causing them to dig the ditch throughout to the depth of 5 feet, and to the width of 7½ feet, which may easily be accomplished in 4 hours, by men inured to labour.

*Secondly—In respect to the Epaulments.* The ditch of each of the epaulments, including the shoulder, being of a more



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irregular form, one cannot assign a certain uniform width throughout, for the task of the men employed there. But it should be explained beforehand, that the task of the 8 diggers employed in these ditches shall be 50 cubic yards in all, or at the rate of 6¼ cubic yards to each man, being precisely the same as that of a digger in the ditch of the parapet.

White pickets, or other conspicuous marks may be fixed in the ditch or on the sides of it, at each extremity of the face of the battery, in order to mark where the excavation belonging to the parapet ends, and that of each epaulment commences, which will be useful in measuring those respective excavations, when the workmen are about to be dismissed.

The task work for the men employed in the execution of the parapet and epaulments of an elevated gun battery should be general, for the whole working-party, and not parcelled out amongst the smaller parties, into which it is sub-divided for the sake of convenience. And it must be fully explained to the men beforehand, that their task will not be considered finished on the mere completion of the quantity of excavation, by which it is to be measured; unless the shovellers and rammers shall have shown equal diligence with the diggers, by finishing the portions of parapet and epaulment obtained from the said excavation properly, instead of leaving them in a slovenly irregular form.

### 17. OF THE TASK PROPER FOR THE SECOND RELIEF OF WORKMEN, IN EXECUTING AN ELEVATED BATTERY IN EASY SOIL.

This task, like the former, may amount to about 6¼ cubic yards of excavation for each of the diggers employed in the ditches of the parapet and of the epaulments, it being understood, as explained in the foregoing article, that the exertions of the other workmen are to keep pace with those of the diggers.

The excavation in the ditch of the parapet will be measured by seeing that its width is doubled, by increasing it from 7½ to 15 feet, still retaining the same depth of 5 feet. The excavation in the ditch of each epaulment, including its shoulder, will be measured in cubic yards, seeing that this also shall be doubled, not by an increase of width, but by a measurement of the whole, which should now amount to 100 cubic yards, instead of 50.

The task of this relief, may be considered rather easier

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than the former, as the diggers have not to throw their earth so high, being now assisted by shovellers also working in the ditch, who throw it upon the berm.

18. OF THE TASK PROPER FOR THE THIRD RELIEF OF WORKMEN, IN EXECUTING AN ELEVATED BATTERY IN EASY SOIL.

It being now daylight, if the enemy should abstain from firing, the men of this relief ought to complete the battery; which may easily be effected by the steady labour of good workmen, in about 4 hours, there being only about 7 cubic yards for each digger, remaining to be done.

The diggers of this relief, should commence by cutting the front part of the ditch 18 inches deeper, before they increase the width of their excavation, as directed in article 6 of this section.

If in the course of the foregoing reliefs, the interior portion of the parapet should have been raised as high as possible, leaving the outer part lower than usual; a considerable portion of the earth wanting, might be thrown up by the shovellers stationed in the ditch, without exposing themselves much; so that some little progress might be made this day, even if the enemy kept up a brisk fire. But in that case, one could scarcely hope to complete the whole of the parapet, still less the epaulments, the ditches of which are liable to enfilade from the fortress.

Upon the whole, instead of assigning a regular task, to the men of this relief, it will be better to keep them employed, for a period not exceeding 8 hours, as much as can possibly be done without exposing them unnecessarily, in any work connected with the battery, that may appear most expedient. And there should be no other relief sent to the battery this day, until after dusk.

19. OF THE TASK, PROPER FOR THE FOURTH RELIEF OF WORKMEN, IN EXECUTING AN ELEVATED BATTERY IN EASY SOIL.

If by reason of the briskness of the enemy's fire, little shall have been done during the first day, by the third relief, let the men of the fourth relief, who commence early on the second night, be required to finish the parapet, and epaulments.

*First.—In respect to the Parapet.* The above being their task, it will be unnecessary to determine it by any fixed



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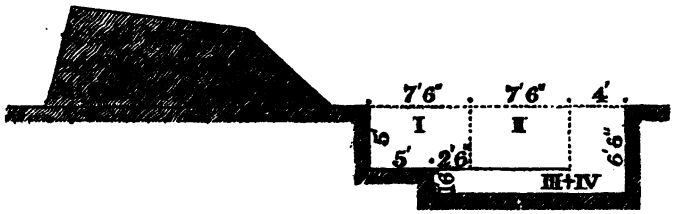
quantity of excavation, as the parapet itself will be the criterion to judge by: but when completed, the ditch of the face of the battery will have attained the extreme width of about 19 feet, as shown in the annexed figure, which represents the several tasks of the four reliefs of workmen employed.




In this figure, the tasks of the first and second reliefs of men denoted by the roman numerals I and II, are defined with that accuracy, of which the first night's work appears to me to be susceptible: but the tasks (III+IV) of the third and fourth reliefs of workmen are blended together, leaving the task of the third relief of men undefined, for the reason before stated.

In those parts of the parapet, behind which traverses are constructed, the ditch will be somewhat wider than 19 feet, as rather more than the usual excavation is required there to complete the great merlons.

*Secondly.—In respect to the Epaulments.* These too will be judged of, by seeing that every part shall have attained the height, thickness, and other dimensions prescribed, without reference to the quantity of excavation, which will be of an irregular form, and of unequal width, when the battery is completed, the curved portions of the ditch opposite to the shoulders being the narrowest parts of the whole ditch of the battery.

### 20. OF THE TASKS PROPER FOR THE SEVERAL RELIEFS OF WORKMEN, IN EXECUTING AN ELEVATED GUN BATTERY IN DIFFICULT SOIL.

*Task of the First Relief of Workmen.*

*First.—For the Parapet.* This task in the most difficult soil, that is to be met with, not absolutely coming under the denomination of rock, should not be less than at the rate of 4 cubic yards for each digger. Hence the trench allotted to the first row of diggers in the ditch of the parapet, they

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being 4 per gun in number, should be about 4 feet 9 inches wide, and 5 feet deep. The second row of diggers should work at the same rate, but being one man fewer, they need not cut their trench much wider than 3 feet and a half.

*Secondly.—For the Epaulments.* The 8 diggers employed in the ditches of each epaulment, including the shoulder as usual, should form an excavation at the same rate, amounting to 32 cubic yards in all, to be determined, not by uniform width, but by measurement.

*Task of the Second Relief of Workmen in difficult soil.*

*First.—For the Parapet.* The second relief of workmen should also execute work equal to the former in quantity, but as the two rows of diggers in the ditch are now both working together, to cut away the tongue, between their respective trenches, it is not easy to determine their proper task by measuring the excavation. I would therefore recommend tasking the men employed about the parapet, to raise the solid to the average height of 2 feet, but directing them to make it at least $2\frac{1}{2}$ feet high inside or towards the rear, and $1\frac{1}{2}$ foot high in front. If care be taken, that this shall be full measure, rather over than under, and that the elevated earth shall be rammed as much as may be necessary, this may be reckoned as nearly as possible equal to the former task.

*Secondly—For the Epaulments.* In respect to each of the epaulments, the task may be to raise it and its corresponding shoulder, to the average height of about 2 feet 6 inches high, internally, and 2 feet high externally.

*Task of the Third Relief of Workmen in difficult soil, being the Relief of the first day.*

This relief coming on duty, on the morning of the first day, and consequently exposed in full view to the fire of the enemy's artillery, must be made as useful as is practicable, without exposing the men unnecessarily. Probably they may not be able to add much to the progress of the parapet or epaulments.

*Task of the Fourth Relief of Workmen in difficult soil, being the first Relief of the Second Night.*

Supposing little or nothing to have been done during the course of the first day, owing to the briskness of the enemy's fire, the first relief of the second night ought to be tasked to finish the solid of the parapet, raising it to the full height of about $3\frac{1}{2}$ feet interiorly, and of about $2\frac{1}{2}$ feet exteriorly: and at this period, the tongue in the ditch ought to be

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removed, and the two original trenches there blended into one by the united labour of the two rows of diggers, according to the system before explained in article 7.

The epaulments should be raised at the same time, by the men of this relief to the average height of about 4 feet, by making them 4½ feet high, interiorly, and 3½ feet high exteriorly.

*Task of the Fifth Relief of Workmen in difficult soil, being the Second Relief of the Second Night.*

*First—For the Parapet.* To complete about one-third of each merlon and half-merlon of the parapet, by raising them to the average height of at least 16 inches above the sole of the embrasure.

*Secondly—For the Epaulments.* Also to raise the epaulments, including the shoulders as usual, to the average height of 5 feet, by making them 5½ feet high interiorly, and about 4½ high exteriorly.

*Task of the Sixth Relief of Workmen in difficult soil, being the Relief of the Second Day.*

The same remark applies here, as to the relief employed on the first day, namely that the men should be made as useful as possible, without exposing them unnecessarily, and that they may perhaps add but little to the progress of the parapet and epaulments.

*Task of the Seventh Relief of Workmen in difficult soil, being the first Relief of the Third Night.*

*First.—for the Parapet.* Supposing that the former relief shall have done little or nothing during the day, owing to the briskness of the enemy's fire,* the men of this relief should be required to raise the merlons about 16 inches higher, which under the foregoing supposition, will raise them to the average height of about 2 feet 8 inches above the soles of the embrasures: and therefore in a gabion battery, the second tier of gabions will at this period be filled, and backed with earth, or nearly so.

* A casualty or two occasionally occurring in a working-party, cannot be considered a sufficient reason to leave off, under all circumstances, and there may even be cases, in which it is absolutely necessary to expose a body of workmen to a galling fire for some important object. Such necessity can however scarcely apply to the first batteries in a regular siege, in the construction of which no useful object could be gained by allowing any part of the men to work without cover under a hot fire of Artillery. The experience of sieges has proved, that the number of casualties amongst working-parties judiciously employed, even in the day-time, bears but a very small proportion to the quantity of ammunition fired at them from the fortress. The loss of lives usually falls heaviest upon the officers of Engineers, or other officers acting as such, who from the nature of their duties, are necessarily the most exposed.

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*Secondly.—For the Epaulments.* Under the same supposition of little having been done during the day, the epaulments must be raised one foot higher, or to the average height of 6 feet, making them about $6\frac{1}{2}$ feet high interiorly, but only $5\frac{1}{2}$ feet high exteriorly.

*Task of the Eighth Relief of Workmen in difficult soil, being the Second Relief of the Third Night.*

To finish the parapet and epaulments.

21. THE SAME SUBJECT CONTINUED. GENERAL RULE FOR THE TASKING OF MILITARY WORKING PARTIES. REMARKS ON THE EXECUTION OF THE FIRST BATTERIES IN A SIEGE.

In the practice of this establishment, the men, generally diligent, have seldom excavated at the rate of less than two cubic yards an hour in easy soil, or at the rate of less than 1 cubic yard an hour, in the most difficult soil, in any work in which they took an interest, such as the construction of a battery: but when excited by task-work, they have usually done more than the above. For example, the two first tasks of a first parallel, 60 yards long, amounting to $6\frac{3}{8}$ cubic yards of excavation per man, were executed in easy soil, by 30 men, in the average of 2 hours and 20 minutes, being within a fraction of 3 cubic yards an hour. And the same tasks, of a similar parallel 64 yards in length were executed by 32 men in the most difficult soil in this neighbourhood, in the average of 5 hours, being at the rate of $1\frac{1}{3}$ cubic yard an hour. In each of these tasks, every individual had his own portion, without assistance from the others: but if they had been made general for the whole of the men employed, as I have recommended in tasking military working parties on service, they would of course have both been executed in less time than the above.

If in the military working-parties in a siege, one could always command men inured to labour and diligently inclined,* it would be by no means difficult to finish the first elevated batteries of a siege, in the stiffest soil, in 2 nights,

* Like the soldiers of his majesty's Foot Guards, in the late wars, whose exertions in the trenches were not inferior to those of the men at this establishment, and as far as my own observation goes, a good deal of their superior efficiency as workmen, over the rest of the British Infantry, arose from the zeal of their regimental officers of all ranks, who seemed to be free from that most pernicious and contemptible prejudice, that to act as overseers or foremen of labourers in the trenches, under the Engineers, was a degradation to what is called the character of a gentleman.

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or by the fifth relief of workmen instead of the eighth. But one cannot safely calculate upon always obtaining workmen of this description in full vigour, and even if such were to be had, one cannot always be sure of making and inforcing the best arrangements: for untoward and unforeseen circumstances creating delay, are always likely to occur on service. Hence upon the whole, it does not seem prudent to calculate upon finishing the first batteries in a siege, if elevated batteries, in less than three nights, in very difficult soil: so that generally speaking, an engineer ought to be contented, if under such circumstances, he can have his first batteries of this description, ready to open upon the fortress, on the morning of the third day, after commencing them.

Having stated that a task of about 6¼ yards of excavation was proper for the diggers in easy soil, and a task of about 4 cubic yards of excavation in very difficult soil, it may here be remarked, that in soils of intermediate hardness or tenacity, a task of about 5 cubic yards, or any other intermediate quantity between these two, may be allotted to each digger, according to the judgment of the engineer.

In suggesting the specific tasks above-named, for very difficult and very easy soil, respectively, I acted upon the following rule, which will perhaps be allowed to afford a fair and reasonable and perfectly practicable criterion.

I recommended in both cases, that the task assigned for each relief of the military working-parties, should be such as we know by the experience of this establishment, that men inured to labour and in full vigour, will execute with ease, in from 3 to 4 hours. And surely, it is not too much to expect, that the British Infantry generally, who although less inured to labour, are not inferior in physical strength to the soldiers of the royal Engineer department, should be able to get through the same quantity of work, when tasked, in at least 5 or 6 hours.

For example, for the elevated battery in easy soil, which has been executed in 11 hours at this establishment, I recommended four reliefs of workmen, and assuming that the third relief employed in the daytime could do little or nothing, this would form a task for each of the three other reliefs, only involving 3 hours and 40 minutes of active labour, to good workmen.

In like manner, for the elevated battery in difficult soil, which has been finished in about 22 hours at this establish-

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ment, one allowed 8 reliefs of workmen, and admitting that 2 out of those 8 are able to do little or nothing, being employed in the day-time, the task allotted to each of the 6 remaining reliefs, will only involve 3 hours and 40 minutes of active exertion to good workmen, as before.

It would be an insult to the soldiers of any regiment in the British service, to suppose, that they could not get through such tasks, in 6 hours at the utmost; especially if the working-parties from the commencement to the completion of each battery, or set of batteries, were furnished by companies, battalions, brigades and divisions; so as to interest the esprit de corps of the officers and soldiers of these organized bodies in the execution of such works, by causing the praise of diligence and the disgrace of extreme idleness or uselessness, to attach to these bodies; instead of employing mixed working-parties, that have no military pride or feeling of this nature at all. But having sufficiently treated of the best mode of superintending military working-parties in the first part of this work, I forbear to enlarge further upon that subject.

In the foregoing articles, I assumed that little could be done in the day-time, towards the progress of the parapet and epaulments. It may, however, be remarked here, that the men in the ditch of the parapet are very little exposed, at the depth of 5 feet, as they usually work stooping: and therefore in stiff soil, they may be employed during the whole day in picking, and in throwing what earth they can upon the outside parts of the parapet and berm; and when they cannot conveniently throw any more up there, they may form a mass of earth on the reverse of the ditch, all ready to throw up at night. By this means, the completion of the parapet will evidently be expedited, even if little shall have been added to it during the day, for at night, extra shovellers may be employed in the ditch, who may go on vigorously throwing up the loose earth collected for them during the day, and when that shall be expended, the diggers will have prepared more for them. Hence the parapet of an elevated battery in stiff soil, may by this process, probably be advanced nearly as much in the course of the second night, as if the soil were easy: and if the diggers exert themselves on the same principle during the course of the second day, the battery may perhaps be finished by the seventh relief of workmen, instead of the eighth.

Towards the extremity of the ditch of the epaulment,

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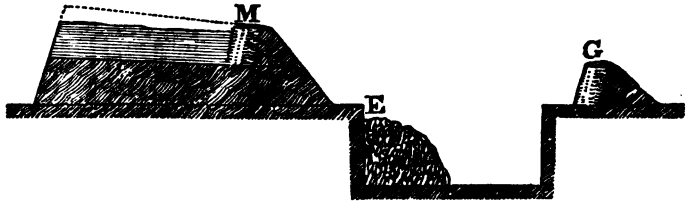
the diggers are exposed to an enfilading fire during the day. Hence they could not do much, unless they were protected by lock traverses, which might be made for this purpose, if deemed expedient,

After the first night's work, or at least towards the evening of the first day, it will be easy for the engineers, on due consideration of the nature of the soil, the effect of the enemy's fire, and other circumstances, to judge whether they can hope to finish their elevated batteries in the course of the second night, or whether they will require a third night's work. In a gabion battery, after completing the solid, if they should foresee, that the men will not be able to do more than half fill the second row of gabions before day-light: it will be better not to place those gabions at all, but merely to raise the center of each merlon by a mass of earth, to be ready for the gabions on the ensuing night.

They may also, if they think proper, use the expedient, of masking each of their embrasures by a transverse row of gabions, towards the front, to prevent the enemy from distinguishing the position of those embrasures, and from seeing men through them, who may be in rear of the parapet.

At an earlier period of the work, they may adopt another expedient, that has often been recommended, namely, the establishment of a gabion screen, resembling the parapet of a flying sap, in front of the ditch of an elevated battery in progress, to cover the diggers and shovellers in the ditch more effectually: but unless exposed to musquetry, it appears to me, that this is scarcely worth while, for as soon as the first excavations or trenches shall have attained the depth of 5 feet, which may be done in a few hours, in the worst soil, the men will be covered enough.




The annexed figure, which is the section of an elevated battery, in progress, and drawing to a close, represents the above arrangements. G is a row of gabions with a small parapet, on the counterscarp side of the ditch, to screen the

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diggers more effectually in the day-time. E is a mass of earth on the reverse of the ditch, loosened by the pickaxe, and thrown there in the day-time by the diggers, all ready to be thrown upon the parapet by-night, that is under the supposition of the soil being extremely difficult: for in easy soil, little would be gained by such an arrangement. M is a mask consisting of a transverse line of gabions, with earth in front of them, to screen the embrasure.

Whether to adopt the above expedient of throwing up a gabion screen in front of the ditch, or not; and in like manner, whether the embrasures of an elevated battery, in progress, should be masked, or not; or whether the still more cautious measure of making the parapet all solid, in the first instance, like a mortar battery, and cutting out the embrasures afterwards, may not be more advisable; are questions which it is impossible for any person to decide upon, beforehand. They must be left entirely to the judgment of the engineer officers employed in a siege; who if they have that degree of intelligence, which the service of the department demands, cannot fail to adopt those or other still more suitable expedients, that will naturally suggest themselves on the spot, and which cannot be foreseen at an establishment like this; still less by speculative writers in their closets, who have not the means of submitting their ideas as they occur, to the test of experiment; which we have repeatedly found to confute the most plausible and apparently judicious arrangements, in respect to such matters, that had not been tried before. Without therefore dwelling further upon such expedients, for which I conceive it impossible to fix any precise rules, and without wishing to lay down the specific number of workmen of each description, suggested in the foregoing articles, as definitive for all cases; but rather as practical examples of the general principles, according to which the construction of elevated batteries may be regulated to the most advantage, and with a view to avoid the waste or misapplication of useful labour; I may conclude by observing, that it will perhaps be acknowledged, that the rules for estimating the precise quantity of labour, that may reasonably be expected in all soils, from the military working-parties employed in the construction of elevated batteries, in a siege, are founded upon such sound data, and involve such a moderate degree of exertion; that if they be so tasked, the chief engineer may without hesitation, move the general in command of the besieging army rigidly

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to exact from each relief of workmen, the full quantity of task-work prescribed; for the due performance of which, the regimental officers of the working-parties should be held responsible, by the general officer on duty in the trenches.

22. OF THE MODE OF RELIEVING THE WORKMEN IN THE SECOND OR THIRD SET OF BATTERIES, CONSTRUCTED DURING A SIEGE.

After the first batteries in a siege shall have opened, which if provided with a sufficient number of heavy guns, mortars and howitzers, judiciously placed, cannot fail in a few days to produce the usual effect of entirely or nearly silencing the artillery of the fortress, the construction of the remaining batteries that may be necessary, to effect the reduction of the place, especially if any of them should like the first be out of musquet shot, or at a very long range of that weapon, becomes comparatively easy; and therefore instead of endeavouring to work with two reliefs out of the three altogether by night, the three reliefs may be sent into the trenches at regular intervals of 8 hours each, it being understood however, that every new battery is to be commenced at night.

23. OF THE QUANTITY OF LABOUR IN A GABION SPLINTER PROOF TRAVERSE FOR AN ELEVATED BATTERY: AND OF THE ARRANGEMENTS PROPER, AND TIME NECESSARY, FOR EXECUTING IT BY ONE RELIEF OF WORKMEN IN EASY SOIL.

*First.—Quantity of Labour.* A gabion splinter proof traverse, 16 feet long, 5 feet thick at the base, and 4½ feet thick at top, and 7 feet high, requires an excavation of about 15 cubic yards to complete it: but if the thickness at the base be increased to 6 feet, without altering the thickness at top, or height, an excavation of about 17 cubic yards of earth will be necessary.

*Secondly.—Number of Workmen necessary.* If we suppose, that it is desired to complete a gabion traverse in the shortest possible time, in very easy soil, 9 labourers may be employed, of whom 3 may be told off as diggers, 4 as shovellers, and 2 as rammers.

*Thirdly.—Arrangement of the Workmen.* Whilst the rammers and shovellers are employed in placing the first gabions, let the 3 diggers commence a trench, 14 or 15 feet long, and 3 feet deep, parallel to the face of the battery, and

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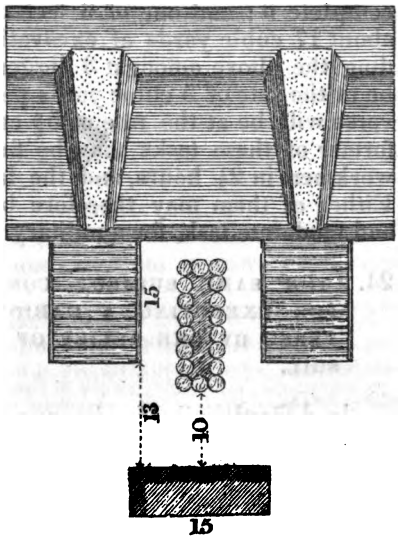
consequently perpendicular to the traverse, and 10 feet in rear of it.

In placing the first course of gabions of a traverse, it is best to set up only about seven of them at first, beginning with those at the front or extreme end, and afterwards placing the others in regular succession, by one pair at a time. And in filling them, it is also best to adopt the same arrangement, beginning with the furthest or most advanced gabions, because after being filled, these will support the empty gabions behind them, and prevent them from being knocked over by earth, thrown from the rear. For the same reason, in previously filling the extreme gabions, the earth ought to be poured gently into them, and not thrown violently, or from a distance.

The rammers will ram the earth in the several gabions, whilst being successively filled, as much as is practicable. The greater care with which the shovellers are obliged to throw their earth in working at a traverse, when they must as it were take a regular aim before every heave, renders their labour comparatively less effectual, than that of an equal number employed, at the parapet or epaulments.

When the traverse is ready for the second course of gabions, it is best to place those towards the front or far end of the traverse the first, and from thence to work backwards, as before, setting up and filling the remainder of them by successive pairs. In this operation, it is most convenient for one or two of the shovellers to get upon the top of the first or finished course, whilst they are filling the second course of gabions in front of them: and thus they will continue, until by degrees, they cease to have standing room, in that position.




The annexed figure, is the plan of a traverse in progress, according to this arrangement. The first course of gabions only is supposed to be placed, and the trench

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15 feet in length, has not yet attained its full width. The platforms of the two guns nearest to the traverse are introduced in the figure, although it is not usual to lay them so soon: in order to show that the trench, from whence the earth for the traverse is obtained, would not interfere with the service of those guns; for being commenced 10 feet in rear of the traverse, it is thereby removed to the distance of 28 feet from the parapet of the battery. Now a 24-pounder on a travelling carriage occupies a space of about 14 feet in rear of the parapet: and when fired with full charges of powder, the medium gun of that calibre recoils about 7 feet, so that the trail of the carriage is then 21 feet distant from the parapet. Hence, even if the excavation shown in the figure, extended all along the rear of the two platforms, it could not impede the manœuvres of the guns, there being the ample space of 7 feet, over and above what is absolutely necessary for the recoil.

As however, a perpendicular excavation in rear of a battery, might not be convenient, the sides of the trench should be formed into gentle slopes, about the time, that the work is drawing to a close.

*Fourthly.—Time required for executing a splinter proof traverse in easy soil, according to the above arrangements.*

It was before stated, that a gabion splinter proof traverse 16 feet long, and 7 feet high, 5 feet thick at the base, and 4½ thick at top, requires about 15 cubic yards of excavation, to complete it: and one of 6 feet thick at the base requires about 17 cubic yards of excavation to complete it. Dividing the above amongst 3 diggers, the 5 foot traverse will be at the rate of 5 cubic yards per man; but the 6 foot traverse will be at the rate of 5⅔ cubic yards per man. The former of these tasks may be finished with ease by good workmen in 2½ hours, and the latter in less than 3 hours. Either of them may therefore be considered a reasonable and moderate task, for a military working-party.

### 24. THE SAME SUBJECT CONTINUED.—ARRANGEMENTS FOR EXECUTING A GABION SPLINTER PROOF TRAVERSE BY ONE RELIEF OF WORKMEN, IN DIFFICULT SOIL.

In difficult soil, 10 labourers may be employed to a gabion traverse, of whom 4 may be diggers, 4 shovellers, and 2 rammers. The 4 diggers in rear of the traverse, will cut

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a trench 18 feet long,* in order that they may have sufficient room to work in line. The same general principle, already explained in the preceding article, will be followed in the execution of the traverse, but there being one more digger employed, the excavation required to complete a 5 feet traverse will be at the rate of $3\frac{3}{4}$ cubic yards, and for a 6 feet traverse it will be at the rate of $4\frac{1}{4}$ cubic yards, for each of the 4 diggers. The former may be accomplished with ease, in about $3\frac{3}{4}$ hours, and the latter in about $4\frac{1}{4}$ hours, in the most difficult soil, by diligent men inured to labour, as the practice of this establishment has proved; and therefore neither of them can be considered an unreasonable task for one relief of a military working-party in a siege.†

### 25. ARRANGEMENTS FOR EXECUTING A GABION SPLINTER PROOF TRAVERSE FOR AN ELEVATED BATTERY, BY TWO RELIEFS OF WORKMEN.

The arrangements, detailed in the two preceding articles, are calculated to complete as many splinter proof traverses, as may be necessary for an elevated battery, by one relief of workmen, that is in the shortest period possible.

But as the traverses are a secondary object, if compared with the parapet of a battery, it is not likely, that an engineer on service, would deem it necessary to use any extra-

* Instead of placing the 4 diggers in one row, in an oblate excavation parallel to the parapet, we placed them at first in two parallel rows, 8 feet apart, to cut an oblong excavation, perpendicular to it, and only 10 feet wide; and as they had no workmen to the right or left to embarrass them, the 2 diggers in rear, forming the second row, were to throw their earth outwards obliquely, towards the front; from which mode of proceeding, more effect was expected, than if they had been obliged to pile it on the tongue immediately in front of them, between their trench and that of the first row of diggers. This promising arrangement disappointed our expectations, and confirmed the maxim deduced generally from our former practice for some years past, namely, that the labour of 2 rows of diggers, throwing their earth in the same direction is in all cases of much less value, than that of an equal number of diggers, having all sufficient room to work abreast of each other.

† A gabion traverse $6\frac{1}{2}$ feet wide at the base, and requiring about 18 cubic yards of excavation to complete it, was recently finished in 3 hours and 10 minutes, at this establishment, by a party of 10 men, working according to the rules laid down in this, and in the preceding article. The soil was the most difficult that could be found in the neighbourhood, which was purposely selected for the sake of experiment. This proves that I have not stated any thing unreasonable, in expecting that a 6 feet traverse may be executed in $4\frac{1}{2}$ hours, by good workmen, since the above, although a larger one was finished one hour sooner than I had calculated upon.

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ordinary exertion to expedite the former, as it is obvious that by employing the smaller proportion of 5 men in easy soil, and of 6 men in difficult soil, he might calculate on finishing a gabion splinter proof traverse with ease, by two reliefs of workmen.

In employing so few workmen, as the last-mentioned proportions, one and occasionally 2 men in easy soil, and 2 men in difficult soil, must dig without intermission. The remainder of the workmen must do every thing else that is necessary to complete the traverse, moving from one part to another, without that distinction between rammers and shovellers, which would only serve to retard the progress of any work, in which fewer men than usual are employed. But the more probable arrangement in respect to the first batteries in a siege, which I have already alluded to, in a former article, is that the engineers would abstain altogether from making any special demand of men for the splinter proof traverses of their elevated batteries. Instead of which, it being probable, that by reason of the briskness of the enemy's fire, few or none of the men, demanded for the general service of the battery, could work at the parapet, during the course of the first day, or of the second day, if the batteries were so long in progress, excepting the diggers in the ditch; the Engineers would employ the shovellers and rammers of the parapet, in constructing the splinter proof traverses in rear of it, in which they would of course, be much less exposed.

### 26. COMPARISON OF GABION, FASCINE, AND SAND BAG SPLINTER PROOF TRAVERSES, FOR AN ELEVATED BATTERY.

*First.—Quantity of Materials required for a Gabion Traverse.* For a 5 feet gabion traverse, 17 gabions in the first course, and 16 in the second course are required, making 33 gabions in all, to which must be added 3 fascines, if an intermediate course of fascines be used between the 2 tiers of gabions, as shown in profile, in the first figure, in page 14.

For a 6 feet traverse, one more gabion in the first course will be necessary, making 34 gabions in all, with 3 fascines as before, if used.

I say if used, because we have often dispensed with them in the traverses made for practice at this establishment, leaving however a mass of earth 9 inches high, between the two courses of gabions, which we have usually reveted with rough sods.

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*Secondly.—Quantity of Materials required for a Fascine Traverse.*

If the traverse be reveted with 9 courses in height, it will require 22 fascines, and 125 pickets, in five of the usual bundles of 25 pickets each. If the revetment be ten courses in height, 25 fascines and 6 bundles of pickets will be necessary.

*Thirdly.—Detail of Workmen for finishing a Fascine Traverse with all expedition.*

The same as for a gabion traverse, but with the addition of 2 builders, making 11 workmen in all in easy soil, and 12 in very difficult soil.

This implies that more than one traverse is going on at the same time, and that the 4 builders belonging to two traverses are united to execute the revetments of both. If there be only one traverse in progress, the number of builders must be increased to 4, it having already been explained that 2 men are not enough to work at a fascine revetment.

*Fourthly.—Of the proportion that the reveting materials bear to the whole mass, in Gabion, and Fascine Traverses.*

In the former kind of traverse, it may be observed, that the gabions bear but a small proportion to the total mass or solidity of the work when finished. In a traverse reveted with fascines, on the contrary, a much smaller excavation is necessary to furnish earth for the body of the traverse, on account of the solidity of the fascines themselves. Accordingly a 5 feet traverse of the same dimensions, that was described in article 23 of this section, if reveted with fascines, requires only about 12 cubic yards of earth to complete it; and a 6 feet traverse only requires about 14 cubic yards of earth to complete it.

Thus whilst 2 builders per traverse, are required for the fascine revetment, who were not necessary in a gabion traverse, the excavation is reduced by about one-fourth: and at the same time, the labourer's part of the work becomes simpler and easier, for the fascines are not raised higher than one course at a time, which causes much less trouble to the shovellers and rammers, than in a gabion traverse.

In respect to the conveyance of the materials, the transport of the fascines requires about double the number of men, that might carry the materials necessary for a gabion traverse: and in both cases, the workmen who are sufficient to finish the traverse itself in one relief with ease, are quite unequal to the task of carrying the necessary materials to



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the spot. For example it would require at least double the number for a gabion traverse, and more than four times that number for a fascine traverse.

*Fifthly.—Quantity of materials for a Sand bag Traverse.*

To revet a 5 feet traverse such as was before described, the sides and ends of which measure 290 superficial feet, 464 sand bags would be required, which in the state proper for building with, may each contain about half a cubic foot of earth, so that the sand bag revetment alone will occupy not much less than one half the body of the traverse.

In building a sand bag traverse, the work of the shovellers and rammers becomes much simpler and easier, than is the case in a gabion traverse, but those diggers in particular who act also as fillers of sand bags, cannot work to so much advantage as the others; and consequently even with a greater number of workmen, which a sand bag revetment in all cases requires, one can scarcely expect to finish it quite so soon, as a gabion traverse.

Sand bags are the only reveting material, of which a sufficient quantity can be carried to complete a splinter proof traverse, by the same number of workmen, who are capable of finishing the whole traverse in one relief.

*Sixthly.—Number of workmen to execute a Sand bag Traverse, expeditiously.*

In easy soil 2 diggers, 2 shovellers, and 2 rammers for the body of the traverse, and 2 builders, 2 fillers and 3 carriers for the revetment, making 13 workmen in all.

In difficult soil, 3 diggers, 3 shovellers, and 2 rammers, for the body of the traverse, and 2 builders, 3 fillers and 3 carriers for the revetment, making 16 workmen in all.

Thus in respect to traverses, as well as the parapet, of an elevated battery, the gabion revetment is the most economical, and the sand bag revetment, the most wasteful, of labour.

Such are the arrangements for executing fascine and sand bag traverses with all expedition, but the same remark applies here, as in the foregoing article, namely that so much exertion is not likely to be considered necessary upon service, and therefore in all probability fewer men would either be employed, if specially demanded for this purpose; or the execution of the traverses would be made to devolve upon the spare men, belonging to the parapet, who might be employed upon the former, whenever the enemy's fire prevented them from working at the latter, without being too much exposed, which of course could only occur in the daytime.

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## 27. OF THE BEST METHOD OF PLACING THE GABIONS IN SPLINTER PROOF TRAVERSES, AND IN REVETMENTS GENERALLY, BEING A NECESSARY SUPPLEMENT TO THE ARTICLE ON GABION REVETMENTS, IN THE PRECEDING SECTION.

It had been repeatedly observed, from time to time, even from the first years of this Establishment, that the parapets of our second parallels, or other works commenced by the flying sap, were apt to bulge backwards, after the full quantity of earth was applied, which was naturally ascribed to the great pressure of that material upon the gabions, and which we took measures to counteract, that need not now be enlarged upon.

In a common splinter proof traverse, the pressure of earth is evidently so very insignificant, that slopes appeared unnecessary; and accordingly we were usually in the habit of making our gabion traverses perpendicular on both sides, according to the profiles explained in articles 10 and 11 of the preceding section. *(See the figures in pages* 14, 15 *and* 16.*)*

Recently, however, and indeed subsequently to the printing of those articles, having made a greater number of successive traverses, than usual, in order to ascertain the best arrangements for executing splinter traverses, expeditiously,* we found that the rectangular profile was objectionable even for traverses, when reveted with gabions; for any little inequality of the ground, on which the first course of gabions was placed, or any other unfavourable circumstance, however trifling, tended to throw the gabions out of their proper vertical position; causing them to bulge over, either to one side or to the other.

On considering this circumstance, as compared with the extreme stability of our gabion batteries, the revetments of which appeared to excel all others in that respect, the reason became obvious.

The mid-section of a gabion being a rectangle, which is known to be the most flexible of figures, and the materials of which our gabions are made being usually very light and pliant, it appeared that the least unfavourable circumstance might alter the gabions from their perpendicular: and by

* Under the superintendence of Captain Willson, who first drew my attention to the circumstance, that is about to be noticed.



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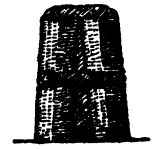
this means, the original profile of the splinter proof traverse was changed from a rectangle into a leaning parallellogram. The ramming of the earth between the gabions too violently was also unfavourable: as it tended to make them bulge out on one or both sides. The men told off as rammers should therefore be cautioned as to this point. They should be directed to ram the earth in the gabions well, but that in the center of the traverse moderately.

In the parapets of our gabion batteries on the contrary, in order to give to the revetment the proper slope of one-fourth, the first course of gabions was always based upon a foundation of fascines, which so very effectually prevented the former from moving, that even in those batteries in which the smallest and lightest kind of gabions were used, the interior revetment of the parapet never altered its form: notwithstanding, that the pressure of earth, comparatively small in a splinter proof traverse, is considerable in an elevated battery.

We have therefore adopted a rule for the future, to give to our gabions, in both courses of a splinter proof traverse, a small slope inwards, on each side, as shown in the annexed figures, the first of which is the section of a 5 feet gabion traverse, the second being the end elevation of what would have been a 6 feet gabion traverse, but which is increased to 6 feet 6 inches at the base, by this rule.



Instead of obtaining the small slope represented in the foregoing figures, by merely pushing the gabions inwards at the top, it may be worth while to introduce a piece of sod at bottom, under the back of each gabion, as shown in figure 2; for there can be no doubt, that the inflexibility of the foundation course of fascines, is the cause of our gabion batteries retaining their form so much better than our second parallels, although the gabions of the former are exposed to a greater pressure of earth, than those of the latter.

### 28. OF THE QUANTITY OF MATERIALS, REQUIRED FOR AN ELEVATED GUN BATTERY, AND OF CONVEYING THEM TO THE SPOT.

*First.—For a Gabion Battery.*

In a regular one-gun portion of the parapet, one fascine,

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and 9 gabions, will complete the solid; 2 fascines and 8 gabions for the back of the merlon, and 4 fascines and 8 gabions for the two embrasures, will complete the upper part of the parapet; making a total of 6 fascines and 16 gabions. One bundle of fascine pickets will be sufficient for securing the fascines, as fewer than the usual proportion will suffice when mixed with gabions.

For the additional parapet, occasioned by a traverse, supposing it to be 6 feet in length, add one fascine, and 6 gabions extra, besides a quarter of a bundle, or 6 pickets.

*Secondly.—For a Fascine Battery.*

In a regular one-gun portion of the parapet, 5 fascines will complete the solid; for the back of the merlon, 5 or 6 fascines, and for the two cheeks of the embrasure, 9 fascines will complete the upper part of the parapet, making 20 fascines in all, which at the rate of one bundle to 4 fascines, will require 5 bundles of pickets.

For the additional parapet, occasioned by a traverse, supposing it to be 6 feet in length, add 4 fascines, and one bundle of pickets.

*Thirdly.—For a Sand bag Battery.*

In a common merlon, or one-gun portion of the parapet, 101 sand bags will complete the solid, which measures 63 superficial feet; 99 sand bags for the back of the merlon, which measures about 62 superficial feet; and 224 for the cheeks of the embrasures, which measure each about 70 superficial feet; will complete the upper part of the parapet.

Thus there will be 101 sand bags in the solid; and 323 in the upper part of the parapet, making 424 in all. A demand of 430 per gun, which number is more easily remembered, will therefore be ample, especially as the cheeks of the embrasures need not be reveted throughout their whole extent.

For the additional parapet, occasioned by a traverse, supposing it to be 6 feet in length, and which consequently will measure 45 superficial feet, add 72 more sand bags.

*Fourthly.—Of the Conveyance of the Materials.*

Having thus stated the quantity of materials necessary for each kind of revetment, noticing what proportion of each sort will be wanted for the solid, or lower part, and how much for the upper part of the parapet; and having in some of the preceding articles of this section, stated the number of reliefs of men, as well as the number of workmen in each relief, that will be required to complete the

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whole battery, it remains for the engineer upon service to consider whether the workmen employed in any relief, including those for the epaulments, will be able to carry as many reveting materials, as will be wanted for the parapet, during the period, that they are to work; it being known, that in addition to tools, one man may carry his share of a fascine in the proportion of one-third, or at the utmost of one-half of the whole weight; or that he may carry 2 gabions, or 40 of the most substantial tarred sand bags;* and also that his share of the fascine will revet only from 4 to 6 superficial feet, whilst the gabions will revet 12 superficial feet, and the sand bags will revet 80 superficial feet, of parapet.

In carrying a load of sand bags, without the assistance of hand carts or barrows, it must previously be divided into two equal parcels, after which the strings of the one are tied to those of the other, and passed over a man's left shoulder, so that one-half of the bags shall hang down before, and the other half behind. Those in front are steadied by one hand, whilst the other is left free to carry tools.

In elevated batteries, no difficulty can be expected to occur in respect to the transport of the necessary materials, for in the easiest soil it is not likely to be finished by less than four reliefs of workmen, and as reveting materials are only required for the parapet and traverses, but none for the epaulments, although these have their regular detail of labourers, it will appear on estimating the whole number of men, employed in those four reliefs at an elevated gun battery, that they will be able to carry all the materials necessary, even for reveting it with fascines, which are comparatively the heaviest of all the common reveting materials. If however, the engineer on duty should find any deficiency of materials likely to occur, instead of keeping the third relief of men all employed at the battery, where it being now daylight, they must work at a disadvantage, being more or less exposed to the enemy's fire; he may send a part of them back from the battery to the engineers depot, to bring up a second and even a third load of reveting materials. In stiff soil, which will require a greater number of reliefs of men than four, to finish the same kind of battery, the

* Forty such sand bags weigh 70 lbs. at 1 lb. 12 oz. each. An untarred bag of the same substantial description, weighs 1 lb. 2 oz. The lighter kind of sand bag, there being two patterns now in use, weighs only 10 ounces.

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workmen themselves will always be able to carry materials enough, when they go on duty, without any part of them being obliged to take a second journey from the trenches to the depot, and back again, for this purpose.

29. GENERAL RULE FOR ESTIMATING THE WHOLE DETAIL OF WORKMEN, FOR AN ELEVATED GUN BATTERY, BEING A RECAPITULATION OF THE FOREGOING ARTICLES.

In estimating the detail of workmen, for an elevated gun-battery, and indeed for any other, it is convenient to assume the number of men proper for a one-gun portion of the parapet, as a scale for the whole calculation, making the men for each of the other parts of the work to bear a certain proportion to the above, either as a multiple or as a part thereof, according as it may involve more or less labour, than the said one-gun portion.

This method will enable an Engineer officer to estimate expeditiously, and yet with sufficient accuracy, the number of workmen for the whole of the batteries, that are to be commenced on the same night of a siege: whereas if he entered into all the details of each part of every battery separately, he would be embarrassed by a number of minute calculations leading to an unnecessary waste of time, and not more satisfactory in the end. This being premised, we will proceed with our subject.

*First.—Number of Labourers per Gun.*

In easy soil to be 9 men at the commencement of the work, and to be increased to 12 or 13 at the second, and remaining reliefs, until the battery is finished.

In stiff soil, to be 11 or 12 men at the commencement of the work, and the last-mentioned number to be employed at the second and remaining reliefs, until the battery is finished.

*Secondly.—Number of extra Labourers for the extreme Half Merlon, when finished without an Epaulment.*

Half as many as for one gun.

*Thirdly.—Number of extra Labourers for the additional Parapet, occasioned by a Splinter Proof Traverse.*

About one-third of the number proper for one gun.

*Fourthly.—Number of extra Labourers for the additional Parapet, occasioned by a substantial Traverse.*

From about one-half to three-fourths of the number proper for one gun.

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*Fifthly.—Number of Labourers for each Epaulment.*

Twice as many as for one gun, it being understood, that this proportion is to be equally divided between the epaulment itself, and the adjacent shoulder.

*Sixthly.—Number of Labourers for the execution of a common Splinter Proof Traverse in one Relief, if required.*

In easy soil 9 men, in stiff soil 10 men, the former being equal to, the latter a little less than, a one-gun portion of the parapet, in each of those soils respectively.

*Seventhly.—Number of Labourers for executing a more substantial Traverse in Two Reliefs.*

The same as the above.

*Eighthly.—Number of Labourers for executing a common Splinter Proof Traverse in Two Reliefs.*

About one-half of the proportion proper for one gun.

The above rules determine the whole number of workmen necessary for a gabion battery, in which a part of the labourers act occasionally as builders.

*Ninthly.—Number of additional men required as Builders in a Fascine Battery.*

Two per gun, and 2 per traverse.

*Tenthly.—Number of additional men required as Builders and their Assistants, in a Sand Bag Battery.*

Four per gun at the first relief: 7 per gun at the third relief, or at whatever period, the embrasures are to be commenced.

If the traverses should also be reveted with sand bags, 7 builders and their assistants will be required for each.

In the execution of an elevated battery, the whole of the above services must be provided for in the first demand of workmen, excepting the traverses, which it is not necessary to begin at the same time with the parapet, and epaulments. The second or third relief of workmen may commence then.

## 30. OF DOUBLE MANNING AN ELEVATED GUN BATTERY WITH LABOURERS IN EASY SOIL. ESTIMATE OF THE NUMBER NECESSARY.

*First.—Definition of the Term, and detailed Explanation of the Process of Double Manning an Elevated Gun Battery.*

It was before stated, that instead of obtaining the whole of the earth for an elevated battery from the ditch in front, a part of it may be procured from a trench in rear, by employing extra diggers there: and when this arrange-

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ment is resorted to, the battery is said to be *double manned* with labourers.

It was also explained in one of the preceding articles of this section, that a 24-pounder on a travelling carriage requires a space of 21 feet in rear of the parapet for its recoil, when fired with full charges of powder, as a battering gun. Hence in double manning an elevated gun battery with labourers, whilst in progress, by employing extra diggers in rear, the front of the excavation from whence they are to obtain their earth, should be cut about 28 feet in rear of the parapet; the extra space, over and above what is necessary for the manœuvres of the gun, being allowed for the base of the front slope, that should be given to the trench afterwards; as it evidently would not be convenient to have a vertical excavation in rear of battery, close to the position of the trail of the carriage after the recoil.

The annexed figure represents a double manned elevated battery in progress, in which earth is obtained from the trench T in rear of the parapet, as well as from the ditch D, in front of it.

The trench in rear is, like the ditch in front, limited to the space of 18 feet per gun, so that 4 diggers only can be employed in one row, in addition to whom one row of shovellers in rear of the parapet is necessary, even at the commencement of the work; and in easy soil a second row of shovellers would be necessary, after the first relief, when by reason of the increased depth and width of the trench, it will become difficult or impossible for the original number of shovellers, to throw the earth furnished by the diggers upon the parapet at one heave, without over-exertion.

When the distance of the trench from the parapet exceeds 30 feet, two rows of shovellers must be employed in rear of the parapet, even at the commencement of the work.

When the distance of the trench from the parapet exceeds 40 feet, or when it is necessary to spread the diggers in an irregular manner, at that or at a greater distance in rear, it will then be a saving of time and labour, to carry the earth to the parapet, and for this purpose strong sand bags

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should be used. These are not only much more convenient than wheelbarrows, which it would scarcely be worth while to carry in the field, but they are lighter and pack into smaller space, even than baskets. Every digger may give employment to nearly 2 carriers, so that 3 diggers may have 5 carriers, and 4 diggers may have 6 or 7 carriers told off to co-operate with them. The carrier holds his bag until it is filled nearly full by the digger, after which, he takes it on his shoulder without tying it, with the mouth of the bag to the front, and holding the loose end of the cloth with one hand, until he reaches the parapet, upon which he empties the contents of his bag. After the merlons are commenced, it will be convenient to make use of platform planks as gang boards, one or two at each embrasure, for these men to ascend by, in order to deposit their earth on the merlons.

In filling sand bags, the diggers are of course obliged to work with more care and with some constraint, and consequently more slowly, than when they only have to throw the earth before them, to a row of shovellers. Accordingly we have found by experiment, that the labour of 2 diggers working at their ease, is fully equal to that of 3 diggers employed as fillers of sand bags. Hence in all cases, in which the earth is to be carried, not shovelled, the value of the work of the diggers in rear of an elevated battery is only equal to two-thirds of that of an equal number of diggers employed in the ditch.

*Secondly.—Estimates of the number of Labourers per gun that may be employed, on a double manned Elevated Battery, in easy soil.*

*Case I.* When the distance of the front of the trench in rear of the parapet does not exceed 28 feet.

| | |
|---|---|
| Diggers in the ditch in front . . . . . | 4 |
| Shovellers on the parapet or berm . . . . | 3 |
| Rammers . . . . . | 2 |
| Shovellers in one row in rear . . . . . | 3 |
| Diggers in the trench in rear of all . . . . | 4 |
| Total number of labourers for the first relief only | 16 |

*Case II.* When the distance of the trench exceeds 28 or 30 feet, and also at and after the second relief of workmen under the former supposition, until the battery shall be finished.

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| | |
|---|---|
| Diggers, shovellers and rammers as before . . | 16 |
| Add a second row of shovellers in rear of the parapet . . . . . | 3 |
| Total labourers . . . . | 19 |

*Case III.* When the distance from whence the earth in rear is to be procured exceeds 40 feet.

| | |
|---|---|
| Diggers in the ditch in front . . . . . | 4 |
| Shovellers on the parapet or berm . . . . . | 8 |
| Rammers . . . . . | 2 |
| Carriers of earth from the rear in bags . . . | 7 |
| Diggers and fillers in the rear of all . . . . | 4 |
| Total labourers . . . . | 20 |

It will of course be understood, that if the supposed battery is to be reveted with fascines or sand bags, the usual proportion of builders and their assistants must be added, over and above the details stated in the foregoing estimates.

*Thirdly.—Estimate of the number of Labourers per Gun, that may be employed in the Epaulments of a double manned Elevated Battery.*

Fourteen diggers, 8 shovellers, and 4 rammers may be employed for each epaulment, (including as usual its adjacent shoulder), making a total of 26 labourers for one epaulment.

There will be room for all the diggers to work in the ditch outside, but one or two must be employed in the usual ramp of communication at the extremity of each epaulment.

### 31. OF DOUBLE MANNING AN ELEVATED GUN BATTERY WITH LABOURERS IN DIFFICULT SOIL. THAT THE SAME NUMBERS ARE PROPER AS IN EASY SOIL.

In stiff soil, the peculiar arrangement of the diggers in front, that applied to a common elevated battery, in which the whole of the earth is procured from the ditch in front, will not answer for a double manned elevated battery: for in constructing the latter, if two rows of diggers be employed in the ditch, both working outwards, or to the front of the battery, at the distance of 12 feet apart, as directed in article 7 of this section; whilst a third row of diggers are employed in rear, according to the system explained in the present article; the parapet of the double manned battery

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might be finished by aid of the trench in rear, before any considerable part of the earth loosened by the second row of diggers in the ditch in front could be used. The labour of these diggers would therefore be thrown away, unless some other arrangement were adopted. Having considered in detail several modifications, in the arrangement of the diggers, both in the ditch and in the rear of a double manned elevated battery in difficult soil, that might be adopted with a view to obtain some benefit from the labour of more than 4 diggers in each of those positions, I forbear to lay them before my readers, as they would require more nicety in the superintendence and execution, than could be expected on service, especially in the dark; and the probable or almost certain confusion, that might ensue, would defeat the possible advantage.

On the whole therefore, I do not recommend employing more labourers in the construction of a double manned elevated battery in the most difficult soil, than would be proper in easy soil, for the details of which, I refer to the foregoing estimates.

### 32. OF THE TIME NECESSARY FOR THE CONSTRUCTION OF A DOUBLE MANNED ELEVATED GUN BATTERY. GENERAL REMARKS.

Assuming that in a double manned elevated gun battery, the four diggers in the ditch can do as much work as those in a common elevated battery, but that the four diggers in the trench in rear can only do two-thirds of the above quantity; it had been anticipated, that the double manned elevated gun battery might be finished in six-tenths of the time required for the completion of a common elevated battery; that is in less than 7 hours in easy soil, and in little more than 13 hours in the most difficult soil, under the supposition of able-bodied men inured to labour, being employed. This expectation has not however been borne out by our practice at this establishment, on a reference to the records of which, it appears, that our double manned elevated gun batteries have seldom been executed much more expeditiously, than our common elevated batteries. In fact, agreeably to the principle before developed, in proportion as the number of workmen on a limited spot of ground is increased, the comparative value of their labour is to a certain degree diminished, even when they are not so crowded as to be in each other's way; for whenever a mass of men are employed, their

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superintendence becomes difficult, and a certain degree of confusion and waste of labour, together with a tendency to idleness, on the part of individuals, are sure to occur; especially in the dark, and with inexperienced working parties composed of troops of the line. If on the contrary, few workmen be employed, each man gets into his place, and finds out what he has to do, with little trouble on the part of those who superintend; and as the conduct of individuals is more conspicuous, greater diligence always prevails. Accordingly, it appears to me, that it would not be safe to calculate upon executing a double manned elevated gun battery, in less than from two-thirds to three-fourths of the time, required for executing a common elevated gun battery of the same description.

How far the time, that may thus be saved by double manning the elevated batteries in a siege with labourers, will compensate the inconvenience of calling upon the besieging army to furnish working parties of nearly double the strength, that would suffice for common elevated batteries, is a question of some importance, that will be fully considered hereafter, as soon as the whole of the other kinds of batteries, that are in common use, shall also have been described in detail.

## SECTION IV.

### RULES FOR EXECUTING SUNKEN GUN BATTERIES.

#### 1. PROFILE PROPER FOR THE PARAPET OF A SUNKEN GUN BATTERY.

A sunken battery was before defined in general terms, as that in which about two-fifth parts of the height of the parapet are sunk below the natural level of the ground. Excepting in this circumstance, the profile of the parapet of a sunken battery differs little from that of an elevated battery, both having the same total relief, as well as the same thickness at top, and their slopes being similar.

The only reason for adopting the sunken in preference to the elevated battery, is the saving of time and labour, that must evidently result from the former construction: for in

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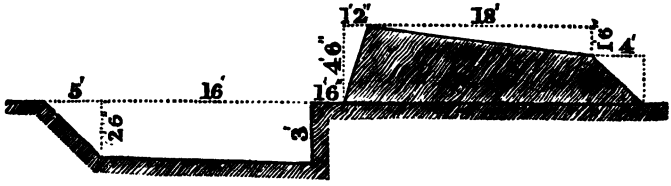
a sunken battery, the merlons only require to be raised above the natural surface, whilst the solid or lower part of the parapet, is composed of the natural ground itself.

In the practice of this establishment, we have usually cut the trench of each of our sunken batteries 3 feet deep in front, and about 2 feet 6 inches deep towards the rear. Leaving a berm of 18 inches between the trench and the parapet, we made the latter 4 feet 6 inches high in rear, 18 feet thick at top, and 3 feet high in front, giving to it the usual interior slope of one-fourth of the height, and allowing 4 feet for the base of the exterior slope, which slope also is by this proportion, rendered similar to that of the elevated profile. These particulars are represented in the annexed figure, being the profile of the parapet of a sunken gun battery.




It will be observed, in the figure, that the trench is 16 feet wide at bottom, with a reverse slope, having a base of 5 feet or in the proportion of twice the height.

For a gun, on a travelling carriage, the sill of the embrasure will bear being raised a little higher than the original level of the ground; 6 inches more of height in rear being required to bring it to the same level, as the sill of the embrasure of the elevated gun battery. It was deemed unnecessary to represent this alteration in the foregoing figure.

For those parts of a sunken gun battery where there are no traverses in rear of the merlons, experience has proved, that a trench of the above dimensions is sufficient to complete the parapet: and in this case, no part of the earth necessary is obtained from the front. Consequently the parapet of a sunken gun battery of this description, has no ditch, and accordingly none is shown in the foregoing figure.

But if any of the merlons have splinter proof traverses in rear of them, the construction of which necessarily interrupts the continuity of the trench in rear, there may be a portion of ditch in front of each of the said merlons, to furnish earth for the parapet there; as the whole of the earth, that

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can conveniently be procured in rear, is required for the formation of the traverse itself.

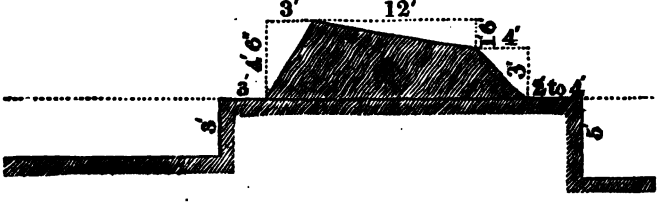
In consequence of the epaulments of batteries being laid out nearly at right angles to the parapet, it is evident, that the same trench cannot furnish earth for both. As therefore almost the whole of the earth, furnished from the extremities of the trench of a sunken battery, is required for the two extreme half-merlons, it follows that each of the epaulments of a sunken battery must have a ditch in front of it, to supply earth for constructing it.

Hence, although there is no general ditch throughout the whole extent of a sunken battery, there may be partial excavations in front of the great merlons, opposite to the position of the traverses, and there is a regular ditch for each epaulment.

## 2. PROFILE PROPER FOR THE EPAULMENTS OF A SUNKEN GUN BATTERY.

The epaulments of a sunken gun battery are laid out by the same rule, as those of an elevated battery, and they have the same total relief, together with the same thickness at top, and similar slopes.

The annexed figure represents the profile of the epaulment of a sunken battery which is 12 feet thick at top, 4 feet 6 inches high in rear, and 3 feet high in front, with an unreveted interior slope having a base of 3 feet, and an exterior slope having a base of 4 feet, each of these slopes being respectively in the same proportion to the height, as in an elevated battery.




Between the epaulment and the trench which forms the interior of the battery, a berm of 3 feet is left, to prevent the risk of any part of the interior slope from giving way. When the epaulment is finished, this berm is diminished to about 1 foot, by sloping the perpendicular side of the trench.

The dimensions of the ditch of the epaulment being of no importance, it need not be made of the precise depth of 5 feet, shown in the figure.

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### 3. RULES FOR TRACING A SUNKEN GUN BATTERY ON THE GROUND.

The same rules nearly apply, as in the tracing of an elevated battery, the principal lines to be traced being, first the interior base lines of the parapet and epaulments, together with the cheeks of the embrasures, which in a sunken battery must form a part of the original tracing, as the merlons commence from the original ground level; and secondly the exterior berm lines of the ditches of the epaulments, and of the portions of ditch in front of each great merlon.

The interior base lines of the battery, and the cheeks of the embrasures may be marked by fascines; and the exterior berm line, of each of the partial ditches in front of the great merlons, may be marked by one fascine.

The exterior berm lines of the epaulments, including the shoulders, may be marked by tracing-lines, or if the battery be commenced in the dark, by white tapes; and the interior berm lines may also be marked in the same manner.

In determining the length of the interior base line of the parapet, 18 feet per gun must be allowed, and to the extra space required for the width of each traverse at the base, which is always laid out on the original level of the ground, from 2 to 3 feet more must be allowed, for the slopes or projections of the lower part of the traverse; besides which 3 feet must likewise be added to allow for the berm of each epaulment, making 6 feet of extra length in all, when there are two. And thus, the interior base line of a sunken battery will generally be longer by 6 feet or more, than that of an elevated battery intended for the same number of guns, and having an equal number of traverses of the like description.

Hence the length of the interior base line of a sunken battery for 6 guns with 2 splinter proof traverses and 2 epaulments, may amount to about 130 feet, according to the following detail.

| | |
|---|---|
| Two half-merlons at 12 feet . . . . | 24 |
| Three common merlons at 18 . . . | 54 |
| Two great merlons at 26 . . . . . | 52 |
| Total | 130 feet. |

The interior base line of each epaulment is laid out with a splay of one foot in 4, and is made 25 feet long, following precisely the same rule as in the elevated battery.

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On a reference to the profile of the epaulment of a sunken battery, given in article 2 of this section, it appears that the base of that work covers 19 feet of ground, in front of which is the usual berm of from 2 to 4 feet.

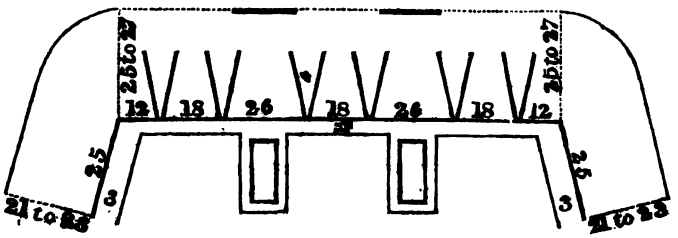
In tracing a sunken battery on the ground, after you have laid out the interior base line of each epaulment, you must therefore trace a line parallel to it externally, at the distance of from 21 to 23 feet, according as the soil is stiff or loose, in order to mark the exterior berm line, of the same.

On a reference to the profile of the parapet of a sunken battery, given in the first article of this section, it appears that the base of that work covers 23 feet 2 inches.

If the parapet had a continued ditch, the exterior berm line might therefore be traced at the distance from 25 to 27 feet, in front of the interior base line. But as there are only portions of a ditch in front of the center of each great merlon, and in front of each shoulder, these portions must be traced parallel to the interior base at either of the above distances of 25 or 27 feet, according to the nature of the soil. And the salient angle, formed by the meeting of the two exterior berm lines at each shoulder, must be rounded off according to rule.

The traverses of a sunken battery must be traced at the same time with the battery itself, which may be done either by fascines or gabions.

The interior berm lines of the epaulments are traced at the distance of 3 feet, and those of the parapet at the distance of 1½ foot, in rear of their respective base lines. The berm lines of the traverses are also traced at the last mentioned distance from the sides and rear of each.




These particulars are shown in the foregoing figure, which represents the outline of a sunken gun battery of the description before specified, as traced on the ground, previously to the commencement of the work. In working



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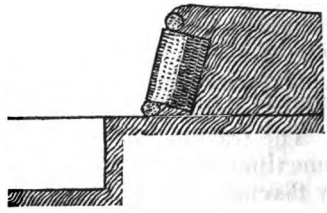
with intelligent men, the tracing of all the interior berms of 18 inches might perhaps be omitted, as the diggers might be directed to leave that space, or so much as may be sufficient to prevent the base of the parapet or of the traverses from giving way, which may be judged of by the eye.

### 4. OF THE METHODS OF REVETING THE UPPER PORTION OF THE PARAPET OF A SUNKEN BATTERY.

In a sunken battery, unless the soil be more than usually loose, there is not much risk of the front of the trench giving way; and accordingly we have always commenced our revetments from the level of the ground upwards; thus only reveting the merlons or upper part of the parapet, in the first instance; which being explained, we will treat in succession of the several kinds of revetments, in use.

*First.—Of Gabion Revetments.*

A course of fascines being first laid to mark the interior base lines of the parapet and epaulments, and the cheeks of all the embrasures, as stated in the foregoing article, one row of gabions is laid over these, with a slope of one fourth for the back of the merlon, and with that varying slope for the cheeks of the embrasures, which has been before explained in Section I, Article 8, in treating of embrasures generally, and in Section II, Article 2, in treating of gabion embrasures, in particular.

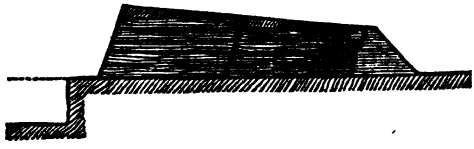


One, or if necessary two courses of fascines are laid over the tops of the gabions, to complete the desired height, as shown in the foregoing figure, which is supposed to be taken through the center of a merlon.

*Secondly.—Of Fascine Revetments.*

In reveting a sunken gun battery with fascines, the same rule is followed, as in reveting the merlons or upper part of an elevated gun battery with the same materials, as described in Section II, Article 3.

The annexed figure is the profile of a sunken fascine battery, taken through the center of an embrasure, and showing one cheek of the embrasure in elevation. The fascines used for reveting the cheeks of the embrasures



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are cut into two 9 feet lengths, for the reason explained in treating of the elevated fascine battery; but they are not laid with a dip towards the front as in that kind of battery, but horizontally, or so as to agree with the level of the original ground, as shown in the figure, which is on a smaller scale than the others.

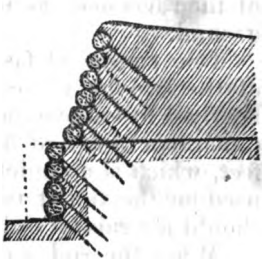
*Thirdly.—Of Sand Bag Revetments.*

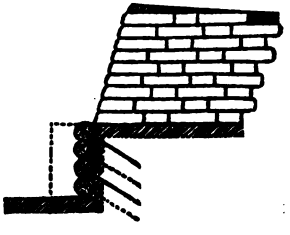
The mode of executing these differs in no respect from the method that ought to be followed, in building the merlons of an elevated sand bag battery, which was fully treated of in Section II, Article 4.

### 5. OF THE METHOD OF REVETING, OR SECURING THE LOWER PART OF THE PARAPET OF A SUNKEN GUN BATTERY.

Whatever reveting material may be used for the upper part of a sunken gun battery, the lower part is always secured by fascines, because it would not be proper to undermine the upper part of the revetment, which is the first finished; and therefore the reveting materials for securing the lower part must project in such a manner, as to form a kind of offset or berm; and if so arranged, gabions or sand bags would evidently take up too much room.

The two annexed figures, one of which is the section of a sunken fascine battery, the other of a sunken sand bag battery, will serve to explain the method of thus reveting the under part of the parapet, which is alike in both, and which is done as follows.





As soon as the merlons are completed, the berm of 18 inches must be cut away, vertically downwards, for the space of 12 feet, in every one-gun portion of the parapet, the center of which space must be under the center of each embrasure. This being done, the front of the trench, thus altered, in each of those spaces, must be reveted by four vertical courses of 12 feet fascines, well picketted into the natural ground, as shown in the two figures, in each of which the original berm is dotted.



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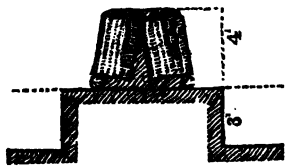
The first of these sections is supposed to be taken through a merlon, the second through an embrasure, so that in the latter, the sand bag revetment of one cheek is seen in elevation.

In loose soil, the berm should be cut away very carefully, and yet as expeditiously as possible, for which purpose three expert workmen should be employed at the same time, in each one-gun portion of the battery. And the fascines being all ready, should be placed, and secured by pickets, without loss of time.*

### 6. OF THE METHOD OF REVETING THE TRAVERSES IN A SUNKEN BATTERY.

The traverses in a sunken battery may either be traced with gabions at once, in two parallel rows, as shown in the former sections of traverses; or with one course of fascines inclosing the rectangular space, which may have been fixed for the base of each traverse. In this case the profile of the work will appear as in the annexed figure, which represents a gabion splinter proof traverse, not exceeding five feet in width at the base of the revetment, as measured on the level of the original ground.




One course of fascines and one of gabions, whichever of the two be placed uppermost, will raise the traverse nearly 4 feet above the original ground level, which in addition to a trench of 3 feet, will give a total relief of about 7 feet, which is as much as can be required. Sods may be used for the top of the traverse, if the fascines or gabions should not raise it quite high enough.

When the soil is so tenacious, that the sides of a trench of 3 feet in depth are not likely to give way, the lower part of the traverse may be left unreveted: but when there is any doubt as to this point, the lower part must be prepared, by cutting away the berm entirely on each side, and scarping down the sides of the trench, so as to alline with the

* In some of the sunken gun batteries made against Copenhagen in 1807, common doors set up on edge, not vertically, but at the usual slope of one-fourth, were used for the same purpose, which were prevented from being forced backwards, by strong stakes driven into the ground in rear of them, at the same slope.

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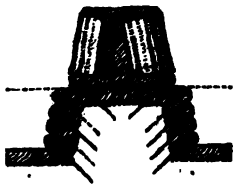
revetment of the upper part of the traverse; which being done, let four courses of fascines be added externally all round, thus leaving a kind of offset of 9 inches at the level of the original ground. These fascines being well bonded into the natural earth, which forming the lower part of the traverse, by pickets driven in the usual manner, will effectually secure it, as represented in the annexed figure, which is the profile of a traverse thus finished.



According to this arrangement, as we suppose the sides of the trench, to have been scarped off at a slope of about one-fourth, the base of the lower part of the revetment may be nearly equal to, but not exceeding, 8 feet, supposing that of the upper part to be 5 feet. But if the saving of space be considered an object, the lower part of the traverse may be reveted perpendicularly, like the parapet, which will reduce its base to 6 feet and a half.

Whatever reveting materials may be used for the upper part of the traverses of a sunken battery, which may either be fascines, gabions, or sand bags, as may be judged expedient; the lower part, if done at all, must be reveted with fascines exclusively; because the other reveting materials, that have been mentioned, would take up too much room.

The passage of 2 feet between the parapet, and the front of a splinter proof traverse need not be cut lower than the level of the original ground, in a sunken gun battery, it being better to put up with whatever inconvenience may result from this arrangement, than to weaken the revetments in front and rear of the passage, by cutting away their base, in a space too confined to admit of berms or slopes.

### 7. OF THE METHOD OF REVETING SUNKEN GUN BATTERIES IN VERY LOOSE SOIL.

The sides of an excavation not exceeding 3 feet in depth will stand in almost every kind of soil; and therefore it can seldom or never be necessary to take further precautions, than those explained in the foregoing articles. If however the soil, in which a sunken battery is to be executed, should evidently be so very loose, that the front of the trench will fall in, if left unreveted, before the upper part of the parapet can be completed; in this case the revetment should not be

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commenced at all, until the trench shall have been cut to the extreme depth of 3 feet in front, and to the width of about 4 or 5 feet, after which, the first course of the reveting materials must be laid along the front part of the sole of the trench, and from thence the remainder of the revetment must be built regularly from the bottom upwards, in the same manner, as in an elevated battery.

Care must be taken, to cause the workmen to throw their earth towards the center of each merlon, as much as may be practicable, instead of piling it on those spaces, where the embrasures are afterwards to be laid out.

When the above arrangement is considered necessary, the center of each of the proposed embrasures, must be marked by a picket, opposite to the line traced for the front of the trench: but the cheeks of the embrasures must not be traced at this period. And the execution of a sunken battery under such circumstances will be attended with more trouble, than in the foregoing supposition, and with some little delay: for it will require at least an hour from the commencement of the work, before the trench will be ready for the placing of the first course of the reveting materials; and until the revetment shall be carried up as high as the proper level of the sills of the embrasures, it will be useless to mark out the cheeks: and thus the labourer's work of the parapet, being always more advanced than the revetment, and even than the proper tracing, must necessarily be in a state of confusion; that is as compared with the progress of the same part of the work, in a sunken battery commenced by the former method. For under the circumstances described in this article, it will be difficult to throw the earth in such a manner, that a part of it shall not have to be moved a second or a third time unnecessarily; which may always be avoided, when the tracing is ahead of the labourer's work.

### 8. OF THE PORTIONS OF BANQUETTE, THAT MAY BE MADE IN SUNKEN BATTERIES, AND OTHERS.

In all gun batteries, it is desirable to have a portion of banquette between every two guns, to enable the artillery officers and gunners to look over the parapet, to observe the proceedings of the enemy, as well as the effect of their own shot upon the works of the fortress.

Very small portions of banquette, or rather mere standing places are sufficient for this purpose, and therefore in an elevated battery they should be so made, in order to avoid

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unnecessary labour: but in a sunken battery, especially if constructed in loose soil, it may add to the stability of the parapet, to allow each portion of banquette to extend nearly from platform to platform of adjacent embrasures. These partial banquettes may be made of earth, either with easy slopes to ascend by, or with a couple of steps of rammed earth, like those of a parallel, or with steps faced with rough sods.* The top of each may be 5 feet lower than the crest of the parapet, or even a little more, as they are not intended for musketry to fire over.

### 9. STATEMENT OF THE QUANTITY OF EARTH, REQUIRED FOR COMPLETING THE PARAPET AND EPAULMENTS, OF A SUNKEN GUN BATTERY.

*First.—For a regular one-gun Portion of the Parapet.*

The trench represented in the profile of the parapet, in article 1 of this section, measures 50¼ superficial feet, which in the space of 18 feet allowed for a common merlon, involves an excavation of 33 cubic yards and a half, but this is increased to nearly 35 cubic yards afterwards, by clearing away the greater part of the berm.

*Secondly.—For the additional Parapet occasioned by a Traverse.*

Every foot in length added to the parapet, or to a great merlon, having a traverse behind it, requires about 2⅐ cubic yards of earth in addition. Hence if we estimate the excavation at the same rate, 8 feet of additional parapet will require 22⅔ cubic yards of excavation to furnish earth for it; and so on in proportion.

*Thirdly.—For the Epaulments.*

The same rule as in elevated batteries may be followed, by estimating the quantity of labour for forming each epaulment, including its shoulder, as being equal to a two-gun portion of the parapet. This is near enough for all practical purposes.

### 10. OF THE QUANTITY OF EARTH, REQUIRED FOR COMPLETING THE TRAVERSES OF A SUNKEN GUN BATTERY.

Supposing a splinter proof traverse for a sunken gun battery to be of the usual length of 16 feet, and to be 5 feet

* The neatest steps for such banquettes, and for field works generally, are those reveted by a couple of vertical courses of fascines; but as this arrangement involves an unnecessary waste of materials, we do not recommend it.

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wide at bottom, as laid out on the level of the natural ground, 4 feet wide at top, and 4 feet high, according to the profile given in article 6 of this section, or a little higher; an excavation of about 10 cubic yards will supply earth enough for forming such a traverse. Indeed a smaller excavation will suffice, considering that the reveting materials themselves occupy a part of the space, contained within the above dimensions.

To calculate the quantity of labour for a larger splinter proof traverse than the above, if such were used, which can seldom or never be necessary, $2\frac{1}{2}$ cubic yards more may be added for every additional foot of base.

Hence if a traverse in a sunken battery were to be made 8 feet wide at bottom, instead of 5, as laid out on the original ground level, for the 3 feet in excess, add to 10 cubic yards, three times $2\frac{1}{2}$ or $7\frac{1}{2}$, and the sum $17\frac{1}{2}$, will be the quantity of excavation necessary, for completing the larger traverse in question.

### 11. OF THE QUANTITY OF MATERIALS NECESSARY, FOR REVETING THE PARAPET OF A SUNKEN GUN BATTERY.

*First.—When the upper part is reveted with Gabions.*

*Common Merlons, or regular one-gun Portions of the Parapet.*—For the back of a common merlon, or of two regular half-merlons, 2 fascines and 8 gabions; for the cheeks of the embrasure 2 fascines and 8 gabions; making in all 4 fascines, 1 bundle of pickets, and 16 gabions in the upper part of the revetment.

For the lower part of the same, if reveted, add 3 fascines and three quarters of a bundle of pickets.

Total 7 fascines, $1\frac{3}{4}$ bundle of pickets, and 16 gabions.

*Great Merlons.*—For a great merlon, having a traverse behind it, supposing the latter to occasion 8 feet additional length of parapet, add to the above detail, 1 fascine, a quarter of a bundle of pickets, and 4 gabions, for the upper part only. The lower part need not be reveted.

*Secondly.—When the whole Parapet is reveted with Fascines.*

*Common Merlons.*—For the upper part of a common merlon, or of two regular half-merlons, 6 fascines: for the two cheeks of the embrasure 9 fascines, making 15 in all, with $3\frac{3}{4}$ bundles of pickets.

For the lower part, if reveted, add 3 fascines, and three quarters of a bundle of pickets.

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Total 18 fascines, and 4½ bundles of pickets.

*Great Merlons.*—For a great merlon, having a traverse behind it, supposing the latter to occasion 8 feet additional length of parapet, add to the above detail, for the upper part only 3 fascines, and three quarters of a bundle of pickets.

*Thirdly.—When the upper part is reveted with Sand Bags.*

*Common Merlons.*—The back of a common merlon measures 72 superficial feet, and each of the two cheeks of the embrasures measures upwards of 80 superficial feet. But as the latter need not be reveted throughout their whole extent; and as some deduction may be made for the two angles at the back of the merlon, which of course require fewer sand bags than the straight portions of the revetment; one may estimate 100 sand bags for the back of the merlon, and 200 for the cheeks of the embrasure, making 300 in all, for the upper part of the revetment.

For the lower part, if reveted, add 3 fascines and three quarters of a bundle of pickets.

*Great Merlons.*—For a great merlon, having a traverse in rear of it, if supposed to be 8 feet longer than a common merlon, as this will add about 36 superficial feet, you may demand 60 sand bags more, than the foregoing quantity.

The above being the nett quantities of materials required for completing each kind of revetment, without making any allowance for waste, it will be proper to provide a certain proportion in addition on that account: and 3 extra fascines must also be provided, for the tracing of two epaulments, 1 extra fascine for each of the partial ditches, &c., with pickets in proportion.

## 12. OF THE QUANTITY OF MATERIALS NECESSARY, FOR REVETING THE TRAVERSES, IN A SUNKEN BATTERY.

*First.—In a Gabion Traverse.*

Three fascines, three quarters of a bundle of pickets, and 16 or 18 gabions, according to the size of the traverse, will suffice for the upper part of the revetment.

For the under part, if reveted, add 10 fascines and 2⅓ bundles of pickets.

Total, 13 fascines, 3¼ bundles of pickets, and 16 or 18 gabions.

*Secondly.—In a Fascine Traverse.*

For the upper part of the revetment, 15 fascines and 3¾ bundles of pickets.

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For the under part if reveted, 10 fascines and 2½ bundles of pickets.

Total 25 fascines, and 6½ bundles of pickets.

*Thirdly.—In a Sand Bag Traverse.*

For the upper part, supposing it to be 5 feet wide at bottom, and 4 feet wide at top, and which consequently will measure about 164 superficial feet, 200 sand bags will suffice; because salient angles require fewer in proportion to their superficial measurement, than revetments laid out in a straight line.

For the lower part, if reveted, add as before 10 fascines and 2½ bundles of pickets.

Total 200 sand bags, 10 fascines and 2½ bundles of pickets.

## 13. OF THE TIME, AND NUMBER OF WORKMEN NECESSARY, FOR THE EXECUTION OF THE PARAPET, EPAULMENTS, AND TRAVERSES OF A SUNKEN GUN BATTERY, IN EASY SOIL.

*First.—Of the Time necessary.*

There being room to employ 4 diggers only to advantage, in a regular one-gun portion of the parapet, which involves rather less than 35 cubic yards of excavation, as was before stated, each digger will have to throw up 8 cubic yards and three quarters, which in easy soil, may be accomplished by an able-bodied man inured to labour, in very little more than four hours and a half. This agrees with our practice at Chatham, in which sunken gun batteries have repeatedly been finished in five hours, without the men being tasked, or otherwise particularly excited to exert themselves.

*Secondly.—Of the number of Workmen per Gun necessary.*

From the above statement of time, it would evidently be useless to employ more than one relief of workmen in executing a sunken gun battery in easy soil. Ten labourers may therefore be demanded, of whom 4 must be employed as diggers, 4 as shovellers, and 2 as rammers. So many shovellers will scarcely be wanted at the commencement of the work; but when the excavation is a little advanced, they may all work to advantage.

Hence in a sunken gabion gun battery, 10 workmen per gun or for each common merlon are sufficient.

In a sunken fascine gun battery, to the same number of labourers, 2 builders must be added, making 12 workmen per gun in all.

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In a sunken sand bag gun battery, to the same number of labourers, must be added 2 builders, 2 fillers and 3 carriers of sand bags, making 17 workmen per gun in all.

*Thirdly.—Of the Number of extra Labourers for the extreme Half-Merlon, when finished without an Epaulment.*

Half as many as for one gun, namely 5.

*Fourthly.—Of the Number of extra Labourers, for the additional Parapet, occasioned by a Splinter Proof Traverse.*

Generally speaking, one extra digger should be employed for every 3 feet. Hence if we suppose the additional parapet to be 8 feet in length and not exceeding 9 feet, 3 diggers in line in the partial ditch in front, together with 2 shovellers, and 1 rammer may be employed, making 6 extra labourers in all. In the case of its being 8 feet, the task of each digger will be rather under 7½ cubic yards, as may be seen by referring back to the statement of quantity, given in article 9 of this section. Supposing the additional parapet to be more than 9 feet, but not exceeding 12 feet, you will therefore employ 4 diggers, also in line, in the partial ditch in front, with 3 shovellers and 2 rammers, making 9 extra labourers in all. The 2 outside diggers must in both cases throw their earth obliquely inwards, because although the diggers are only to furnish earth for 3 feet of parapet each, they themselves must not of course be crowded into so small a space.

*Fifthly.—Of the Number of Labourers per Epaulment necessary.*

Double the number that are proper for a one gun portion of the parapet; but as the men in the ditch of the epaulment are always nearer to their work, I would tell them off into 9 diggers, 7 shovellers, and 4 rammers, making the same number of 20 men in all, but not employing the diggers and shovellers in equal numbers, as in the distribution recommended for the parapet.

It may scarcely be necessary here to repeat, that the epaulment includes the shoulder as usual, in addition to which, the labourers, told off for this part of the work, should also be required to execute the extra 3 feet of length given to the extreme half-merlon adjoining, on account of the interior berm of the epaulment.

*Sixthly.—Of the Number of Workmen per Traverse necessary.*

A traverse of 5 feet and not exceeding 8 feet wide at the base, as measured on the natural ground level, may have 2 diggers, 2 shovellers, and 2 rammers employed about it, making 6 workmen in all.

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A 5 feet traverse, which is such as would require about 8 feet additional length of parapet, involves only 10 cubic yards of excavation, or 5 yards per man to each of the two diggers, which is an easier task than that of the other diggers employed about the parapet. An 8 feet traverse would just equalize the tasks of all, as you may see by a reference to the statement of quantity given in article 10, of this section: but a traverse of this size is larger than can generally be required.

To return to the proper subject of this article, the above mentioned number of 6 labourers is therefore sufficient, for the construction of a gabion traverse.

For a fascine traverse, to the same number of labourers, add 2 builders, making 8 workmen in all.

For a sand bag traverse, to the same number of labourers, add 7 builders and builders' assistants, making 13 workmen in all.

### 14. OF THE TIME, AND NUMBER OF WORKMEN, NECESSARY FOR THE EXECUTION OF A SUNKEN GUN BATTERY, IN DIFFICULT SOIL.

*First.—Time required.*

It having been before stated, that the task of each digger will not exceed $8\frac{3}{4}$ cubic yards, which may be executed by able-bodied men inured to labour, in less than 9 hours in the most difficult soil; it will be proper to employ two reliefs in the execution of a sunken gun battery in very difficult soil, according to the rule before laid down, that the task allotted to a common military working party, shall not much exceed what may be accomplished by good workmen in about 4 hours.

*Secondly.—Number of Workmen necessary for a regular one-gun Portion of the Parapet.*

In very difficult soil, 7 diggers per gun, may be employed in two rows. Four diggers in the first row will commence excavating the front of the trench in rear of the interior base line, leaving the usual berm of 18 inches, whilst 3 diggers in the second row will commence an excavation parallel to the former, at the distance of 12 feet, more to the rear, and they will pile their earth on the tongue between the two excavations, instead of throwing it forward. This arrangement is represented in the annexed figure, which is the section of a sunken fascine gun battery in progress, supposed to be taken through a merlon. The respective trenches of

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the first and second rows of diggers are denoted by the corresponding Roman numerals, I and II.

In difficult soil 3 shovellers will be enough, to whom add 2 rammers, which will complete the detail of labourers 12 in number, for each one gun portion of the parapet.

Thus the number of labourers to each one gun portion of the parapet will be 2 more in very difficult, than in easy soil.

For a fascine battery, add 2 builders, making 14 workmen per gun in all.

For a sand bag battery, to the same number of labourers, add 2 builders, 2 fillers, and 3 carriers, making 19 workmen per gun in all.

*Thirdly.—Of the Number of extra Labourers, for the extreme Half-Merlon, when finished without an Epaulment.*

Half as many as for a one gun portion, namely 6.

*Fourthly.—Of the Number of extra Labourers, for the additional Parapet, occasioned by a Splinter Proof Traverse.*

Supposing this additional space to be 8 feet, employ 3 diggers, in line, in the partial ditch in front with 2 shovellers, and 1 rammer, making 6 extra labourers in all.

When the additional space is more than 8 feet but not exceeding 11, employ 4 diggers, also in line, 3 shovellers, and 2 rammers, making 9 extra labourers in all.

Both of these details are nearly the same, that were before recommended for easy soil: and the same remark applies, that the outside diggers shall throw their earth obliquely inwards.

*Fifthly.—Of the Number of Labourers per Epaulment necessary.*

Double the number of labourers, for a one-gun portion of the parapet, namely 14 diggers, 7 shovellers, and 3 rammers, 24 in all.

These men are not only to execute the epaulment, including the shoulder as usual, but also the 3 feet extra of the adjoining half merlon, occasioned by the berm of the epaulment. Altogether there will be room for the whole of the

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diggers to work in line in the ditch outside, excepting one, who may be employed in the trench inside, near to the extremity of the epaulment, as this oblique portion of the interior trench does not properly belong to the parapet.

*Fifthly.—Of the number of Workmen per Traverse necessary.*

For a common splinter proof gabion traverse of 5 feet and not exceeding 7 feet in width at the base, as measured on the original ground line, employ 2 diggers in rear of the position of the intended traverse, 2 shovellers and 2 rammers, making in all 6 labourers, being the same detail as was recommended for easy soil.

For a fascine traverse, add to the above number of labourers, 2 builders, making 8 workmen in all.

For a sand bag traverse, to this same number of labourers, add 2 builders, 2 fillers, and 3 carriers, making 13 workmen in all.

If the traverse should exceed 7 feet in width at the base, which is not likely to be required, add a third digger to each of the above details, which will increase each several number before stated, by one man.

### 15. OF THE TASKS PROPER FOR THE FIRST AND SECOND RELIEFS OF WORKMEN, IN DIFFICULT SOIL.

*First.—Task of the first Relief of Workmen.*

*Common Merlons, or regular one-gun Portions of the Parapet.*—Let the first row of diggers in the trench in rear, be required to complete their excavation to the width of 6 feet, making it 3 feet deep in front and nearly 2 feet 10 inches deep in rear. The 3 diggers of the second row will make their trench 4 feet wide, cutting it 2 feet 7½ inches deep in front, and 2 feet 6 inches deep in rear. They will then cut an additional excavation in rear of and in continuation of the former, making it 2 feet wide, but only 1 foot 6 inches deep. This will form a step 1 foot high in the reverse of their original excavation. At this period, the diggers of both rows will have executed nearly 3 cubic yards of excavation per man. They will then cease to extend their respective excavations further, but will work in concert in throwing the loose earth from the tongue upon the parapet. When the executive engineer shall be satisfied that the two excavations are cut to the full dimensions above specified, and that about one-fourth part of the earth loosened by the second row of

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diggers has been thrown upon the parapet, the men of this relief should be allowed to go.

*Great Merlons.*—In respect to the partial ditches in front of the great merlons, the diggers employed there, being spread out in line at the usual interval of 4½ feet per man, must be directed to form an excavation 5 feet in depth, and 4 feet 9 inches wide, being at the rate of nearly 4 cubic yards per man along the whole extent of ground thus occupied. This will rather more than half finish the extra parapet, for which these diggers and the other men who co operate with them, were demanded.

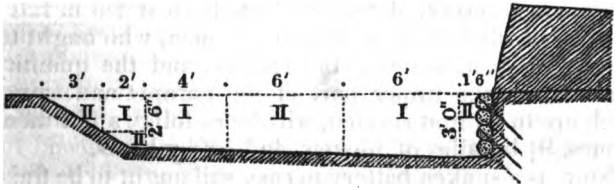
*Epaulments.*—In respect to the epaulments, let the men employed about them be tasked to raise them to the average height of about 2 feet above the ground, which will be rather more than half the mass of earth required; but as the exertion increases with the height, it may be considered a fair division of the labour.

*Traverses.*—In respect to the traverses, the diggers employed about each will commence 2 or 3 feet in rear of the end of it, in order that they may not interfere with the second row of diggers of the parapet: and they also will be spread out in a line parallel to the end of the traverse, at the distance of 4½ feet per man: and they will be tasked to make an excavation 3 feet deep and about 7 feet 6 inches wide, along the whole extent of ground, thus occupied. This will more than half finish the traverse.

*Secondly.—Tasks of the second Relief of Workmen.*

To finish the parapet, epaulments, and traverses.

To illustrate the subject of this article, two figures are annexed. The first represents the tasks of the men employed in the trench of a regular merlon, or one-gun portion of the parapet. The three spaces, I, I, and I, are the excavations formed by the two rows of diggers of the first relief, that space which is nearest to the parapet being the task of the first row of diggers. The four remaining spaces, II, II, II, and II, are the excavations executed by the men of the second relief.

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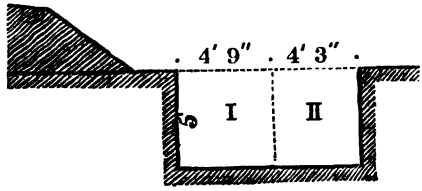


The second figure annexed represents the tasks of the men employed in the partial ditch in front of each great merlon, the rectangular spaces I and II, being the respective excavations of the diggers of the first and second relief.

16. OF THE TRANSPORT OF THE NECESSARY REVETING MATERIALS, FOR A SUNKEN GABION GUN BATTERY IN EASY SOIL. THAT CARRYING PARTIES ARE NECESSARY FOR THIS PURPOSE, IN ADDITION TO THE REGULAR WORKING PARTIES.

Having laid down in sufficient detail all the particulars for deciding upon this subject, it is proper to observe, that it will become a question of some importance, and not unattended with difficulty, for the engineers on duty in a siege, to consider in what manner they will provide for the transport of the necessary reveting materials, to the spot upon which each of their sunken gun batteries is to be constructed.

Without pretending to lay down any fixed rule for making such arrangements, which must depend upon circumstances, that may not always be alike, and which therefore must necessarily be left to the judgment of the Officers at the scene of action; it is right to prepare the mind of the reader, for the difficulty in question, which is never felt at this Establishment, as we seldom make more than one sunken gun battery at a time; and which has not to my knowledge been alluded to, by any former author on the subject. This being premised, I shall proceed to give a few practical examples to elucidate this matter.

Supposing that the battery is intended for 6 guns, with 2 traverses and 2 epaulments, and that all its dimensions agree with the figure given in article 3 of this section, as an example of the tracing of a sunken battery: on referring to the various necessary data, that have been stated in full detail, you will find that the number of men, who ought to be employed in commencing the battery, and the quantity of materials, for the upper part of the parapet and traverses which are to be first reveted, will be as follows 124 men, 37 fascines, 9¼ bundles of pickets, and 140 gabions.

Now, as a sunken battery in easy soil ought to be finished

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by one relief of men, it will evidently be impossible for the workmen themselves to carry the above reveting materials from the engineers' depot to the trenches, at once; and with the exception of perhaps about 12 fascines, and pickets in proportion, it is absolutely necessary that the whole of the above materials shall be on the spot, at the commencement of the work.

To carry 140 gabions will require 70 men, for 37 fascines 74 men, for 9¼ bundles of pickets 5 men; total 149 men, being 25 men more than the number required for the execution of the work, after the materials are on the spot. Now to send back any part of the men told off for the construction of the battery, to fetch a second load of materials from the engineers' depot would evidently be improper; as it would not only render it impossible to complete the work with proper expedition, but might lead to much confusion.

The extra men required to convey a part of the reveting materials to the spot, must therefore be a fatigue party, told off for that special duty, and for no other.

The next point to consider is, at what time it will be most expedient to employ this carrying party.

*First supposition.*—If no impediment should occur to render it impracticable or inexpedient, to effect this object in the day-time, it appears to me, that the best time for accomplishing it, will be in the course of that day, on the evening of which the batteries are to be commenced. In this case, as it is not likely that the engineers' depot shall be much more than a mile distant from that part of the trenches where those batteries are to be situated, the carrying parties will probably be able to make at least four journeys with materials, without over exertion. It now remains to determine their number, under the circumstances supposed.

As it must be of importance, that the workmen who are to execute the battery itself, shall not be overloaded, in their journey from the engineers' depot, to the spot, and as a stout 2 feet gabion may weigh as much as 40 lbs.; it appears to me, that one gabion and a pair of tools are a sufficient load for each of those workmen. As there are to be 124 workmen, if these carry each one gabion, there will remain 16 gabions, besides 37 fascines, and 9¼ bundles of pickets to complete the upper part of the revetment; in addition to which 38 more fascines, and 9½ bundles of pickets will be wanted for the lower part of the revetment of the parapet and traverses. Total 16 gabions, 75 fascines, and 18¾ bundles of pickets,



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the transport of which is to be provided for by a carrying party.

To take the whole of these in one journey, at 2 gabions, or 2 bundles of pickets, or half a fascine per man, will require a carrying party of 168 men: and to carry them in 4 journeys as proposed will therefore require 42 men. Consequently the latter number of men must be demanded as a carrying party, during the day preceding the commencement of the battery, that is to say if it can be done by day without inconvenience.

These carrying parties will not of course be able to deposit their materials on the precise spot, where each battery is to be constructed, since they would there be exposed to the full view and fire of the enemy. But they may always approach very near to it; for the batteries in a siege are either constructed, immediately in front of, or in connection with, some parallel previously finished.

The carriers for each battery must therefore be directed to deposit their reveting materials on the reverse of the parallel, as near to the intended position of their respective batteries as possible.

The local depots of reveting materials thus formed, at a distance from each proposed battery, which need not exceed 50 yards at the utmost, will be of great use; as the working parties, who come on duty at night, after depositing their own materials on the proper spot, may go back to the adjacent local depot, for a second or even a third load, if necessary, with very little loss of time.

*Second Supposition.*—If on the contrary, either from the briskness of the enemy's fire, or other sufficient cause, it should be deemed inexpedient to employ a carrying party to make repeated journeys of this kind during the day, it will be necessary to convey the greater part of the reveting materials to the spot, at the same time that the working party itself goes on duty in the trenches: and as this service will not, under our present supposition, admit of more journeys than one, for those materials are all wanted to begin with; it follows, that in addition to the working party required for commencing each sunken battery, there must be a carrying party of nearly equal numbers to convey to the spot, those extra materials, that the men of the working party cannot carry themselves, without such over exertion as might unfit them for the labour of constructing the battery.

Under this second supposition, therefore, in addition to the working party of 124 men, there should be a carrying

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party of 87 men demanded, to go on duty at the same time; and these two parties in conjunction, even supposing the former to be less heavily loaded than the latter, will be able to convey as many of the reveting materials to the spot, as are necessary for the upper part of the revetments of the parapet and traverses.

As soon as the carrying party, who ought to march immediately in rear of the working party, shall have deposited their load, they will go back to the engineers' depot, and receive a second load of reveting materials to complete the under part of the same revetments; after which they will again return to the depot to receive other useful materials, such as a part of the woodwork for the gun platforms, or field powder magazines, which they will carry from thence to the battery; until they shall have made three or four journeys in all, between the depot and the trenches; the latter number being of course preferable, if it can be accomplished without harrassing the men by over exertion. This should always be avoided in the protracted labours of a regular siege.

### 17. OF THE TRANSPORT OF THE NECESSARY REVETING MATERIALS, FOR A SUNKEN FASCINE GUN BATTERY IN EASY SOIL.

Applying the considerations that were developed in the preceding article, to the construction of a sunken gun battery of the same description, if reveted with fascines, you will find on calculation, that the number of men, and quantity of materials for the upper part of the revetment will be as follows: viz. 140 workmen, 131 fascines, and about 33 bundles of pickets,

To carry those materials in one journey, no less than 279 men will be required, that is double the number of the regular working party, who are capable of finishing the battery in one relief, if supplied with all the materials necessary.

To the above materials add 38 fascines and 9½ bundles of pickets, which may be required for the lower part of the revetment of the parapet and traverses: and this will give employment to 81 men more as carriers.

Here then, the same difficulty occurs as in the preceding article; and the same arrangements naturally suggest themselves to get rid of it.

*First.*—To employ a carrying party in the day time, to deposit a sufficient quantity of fascines and pickets on the



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reverse of the parallel, near to the situation proposed for the sunken battery. For this duty, admitting that they can take four journeys during the day, about 55 men may be demanded; but if it were deemed expedient, that the 140 workmen should each carry only one third part of a fascine, besides their tools, in order not to over-fatigue them before they commence the battery, in this case it would be proper to demand a carrying party of about 70 men to convey materials during the day time at four journeys, each of whom, as they have to perform no other kind of work, may be loaded with half a fascine, or with 2 bundles of pickets.

*Secondly.*—Under the supposition, that any strong objection should exist to the above arrangement, it will be necessary to employ a working party of 140 men, and a carrying party of the same number, both going on duty at the same time in the evening, and even if the former carry only one third of a fascine each, whilst the latter carry one half of a fascine, or 2 bundles of pickets, per man, the whole of the reveting materials will be conveyed to the battery at the second journey of the carrying party, who must therefore be directed, according to the system explained in the preceding article, afterwards to carry a part of the woodwork for the platforms and field powder magazines, until they shall have made four journeys in all from the engineers' depot to the trenches, if practicable without over exertion.

### 18. OF THE TRANSPORT OF THE NECESSARY MATERIALS FOR SUNKEN GABION GUN BATTERIES, AND FOR SUNKEN FASCINE GUN BATTERIES, RESPECTIVELY, IN DIFFICULT SOIL.

*First Supposition.*—If it should be practicable to deposit a sufficient quantity of reveting materials on the reverse of the parallel, adjacent to the position of the proposed sunken battery, during the day-time; this measure should by all means be resorted to.

*Second Supposition.*—If the above arrangement, of conveying a part of the necessary reveting materials during the day-time, should prove impracticable, it will be evident, that in addition to two reliefs of workmen for the execution of the battery, one carrying party of nearly equal strength to one of those reliefs, must be employed at night.

Now in a gabion battery, the greater part of the materials for reveting the upper part of the parapet and traverses, being about three-fourths of the whole quantity required to

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complete, must be upon the spot, at the very commencement of the work. In the fascine battery on the contrary, it is unnecessary to have more reveting materials to begin with, than the first relief of workmen can themselves carry and use.

Hence in the sunken gabion gun battery, the carrying party must go on duty with and accompany the first relief of the working party to the trenches at night; whereas in the sunken fascine gun battery, they may follow the second relief of workmen, and carry in three or four successive journeys the woodwork for the platforms and powder magazines, in addition to the small proportion of reveting materials which will fall to their share. The latter arrangement appears less likely to harrass the troops; and less liable to confusion than the former: but of course it cannot be substituted for it, when gabions are used.

### 19. OF THE TRANSPORT OF THE NECESSARY REVETING MATERIALS, FOR A SUNKEN SAND BAG BATTERY.

Supposing, as in the preceding articles, that the proposed sunken battery is to be for 6 guns, and to have 2 traverses and 2 epaulments, and to be in all respects of the dimensions before specified; you will find the workmen and materials necessary in easy soil, on estimating them according to the data before laid down to be as follows, viz.: 180 men, 43 fascines, 10¾ bundles of pickets, and about 2320 sand bags.

These materials, which are not merely sufficient for the upper part of the revetment, but to complete the under part also, may be carried with ease, by the above number of men, who are capable of completing the battery in one relief, in easy soil.

Hence, the sand bag revetment, although the most wasteful of labour, in an elevated gun battery, as was repeatedly before mentioned in the preceding section, is not so, in respect to sunken gun batteries, as it is the only one which requires no carrying party for transporting and part of the reveting materials; and in difficult soil, in which 2 reliefs of men are required to complete the labourers work of the battery, the second relief of the working party may carry a load of platform or magazine timbers from the engineers' depot to the battery, without over exertion, when they go to work, which will of course considerably expedite the completion of the battery.

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## 20. OF THE PRECAUTIONS NECESSARY TO PREVENT SUNKEN BATTERIES FROM BEING INUNDATED, IN RAINY WEATHER.

If the parallel, with which a sunken battery is connected, should happen to be on rather a higher level, a dam must be made at each boyau of communication, to prevent the rain water collected in the parallel, from flowing towards and into the battery. As the difference of level cannot be great, a rise of about 1 foot will suffice for this purpose. Care must also be taken, that no hollow or declivity of the natural surface shall act as a drain to lead the rain water from the neighbouring ground into the battery. This may easily be remedied, unless the situation chosen should be altogether unsuitable for the position of a sunken battery; which is not likely to occur, without some extraordinary and unaccountable oversight, such as can scarcely be anticipated on service.

Having therefore, by a few simple arrangements, which involve little labour, prevented all but the vertical rain water which falls upon the area of the battery itself, from collecting there; the sole of the trench of the battery must have two or three sess-pools formed in it, any where, so as not to interfere with the service of the guns; and the general surface being so formed, as to lead the rain water into those sess-pools, it must be baled out occasionally with buckets. The necessity of adopting this precaution, simple as it is, might not always occur before hand, to the officers employed in a siege, and therefore I repeat it a second time,* as the neglect thereof, through inadvertency, might lead to much embarrassment, in the event of a sudden and violent rain storm, which might not only inundate all the sunken batteries,† but might injure or destroy a part of the ammunition contained in the field powder magazines attached to them, the interior of which is also sunk below the natural ground level.

* I use this expression, because the same expedient was recommended in the first part of this work, for securing the parallels and approaches against the same evil.

† At Copenhagen, owing to a neglect of this precaution, one of our mortar batteries was filled with water to such a height, that only a small part of the muzzle of each mortar could be seen above the surface. An intelligent private of the Foot Guards, employed on a working party, suggested the remedy, whilst the Artillery Officer and I were anxiously deliberating what was to be done.

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21. THAT THERE ARE CERTAIN SITUATIONS, TO WHICH SUNKEN BATTERIES ARE ALTOGETHER INAPPLICABLE, AND OTHERS, IN WHICH THE SUNKEN PROFILE OUGHT NOT TO BE USED FOR DIRECT GUN BATTERIES.

To marshy soil, in which water is found at about a foot beneath the surface, the sunken profile is evidently inapplicable, whether the battery be intended for mortars or for guns, for a vertical or for a horizontal fire.

When the soil is dry for several feet below the surface, so that no practical difficulty occurs to prevent the construction of the battery, there may be some inequalities of the surface intervening between the site of the proposed battery, and those works of the fortress that are to be attacked by it, such as may render the sunken profile improper for a gun battery intended for direct firing.

For example, it is evident that the shot fired at full charges from a heavy gun, in direct firing, must pass through the air nearly in a straight line, at short ranges. But the muzzle of the gun in a sunken battery is placed very little higher than the original level of the ground. Hence on considering, whether any given spot is proper for a sunken gun battery, for direct firing, the engineer officer should lie down upon the ground, in order to enable him to decide properly. Having thus lowered his eye to the same level, that the muzzles of the guns in such a battery will afterwards assume, if he can see the works of the fortress in this attitude, he need not scruple to adopt the sunken profile for his proposed battery. If on the contrary, any inequality of the ground should intercept his view of those works, he must reject the sunken, and adopt the elevated profile.

In undulating or uneven ground, even the elevated profile may not answer for direct gun batteries, in all situations. It will therefore be most prudent for the engineer officer, in examining whether any situation is proper for an elevated battery intended for this kind of firing, to lower his eye to the level of about three feet and a half above the surface of the ground, which he may do by looking along the top of a rod of that height, or by kneeling. If in this attitude he can still see the works of the fortress, it is a proof, that the ground in question offers a fit position for an elevated battery, of the description proposed, not otherwise.

Thus in gun batteries intended for direct firing, one cannot be too particular, in examining the nature of the ground, if at all irregular, before the sunken profile is adopted; and

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for such ground, even the elevated profile may not always answer. But if mortar batteries, or gun batteries for ricochet firing exclusively, are to be constructed, there can be no necessity for examining the ground so minutely. Any spot, from whence the observer, when standing upright, can see the enemy's works at all, will evidently offer a fit position for such batteries; as the shells or shot fired from thence are not to be impelled in a straight line, but at an angle of elevation.

## SECTION V.

### RULES FOR EXECUTING HALF SUNKEN GUN BATTERIES.

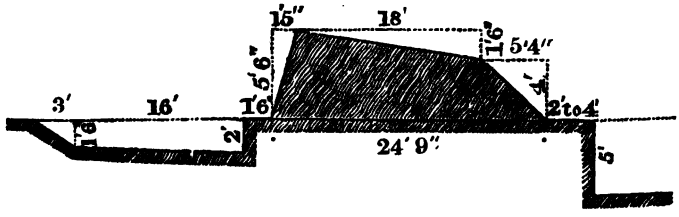
#### 1. OF THE PROFILES, PROPER FOR THE PARAPET AND EPAULMENTS OF HALF SUNKEN GUN BATTERIES.

A half sunken battery was before defined in general terms, as that in which about one-fourth part of the extreme height of the parapet is sunk below the natural level of the ground: and it was stated, that in a gun battery of this description, the sole of the embrasure is about half sunk below that level.

In a half sunken battery, the earth is partly procured from the trench in rear, and partly from a ditch in front, which is continued throughout the whole extent of the work, like that of an elevated battery.

In the practice of this establishment, we found it convenient to make the trench of each of our half sunken batteries, 2 feet deep in front, and about 18 inches deep at the distance of 16 feet to the rear, with a very gentle reverse slope.

*Profile of the Parapet.*—The profile of the parapet of the half sunken battery has the same thickness at top, and dip, similar slopes, and the same total relief, as that of the elevated battery, from which it is deduced by the same rule, according to which the profile of the sunken battery was regulated, as explained in the first article of the preceding section.

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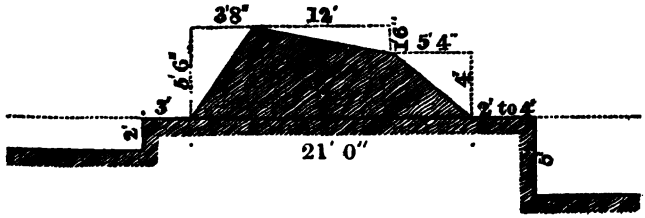
The figure above annexed is the profile of a half sunken battery, thus determined, which is supposed to be taken through the centre of a merlon, and consequently does not show the embrasure. It differs only from a sunken battery, in the trench being 1 foot shallower, and consequently the parapet being 1 foot higher throughout, owing to which circumstance the base of the parapet spreads out to a greater width than that of the sunken profile, by about one foot and a half.

The interior berm of the half sunken battery is of the same width as that of the sunken battery. Its exterior berm may be of the same width, and its ditch of the same depth, as in the elevated profile.

*Profile of the Epaulment.*—The second figure annexed below is the profile of the epaulment of a half sunken battery, which is in like manner deduced from that of an elevated battery, and which as compared with that of the sunken




profile is 1 foot higher throughout above the natural ground level, and occupies about 2 feet more in width of base, upon that level.

## 2. RULES FOR TRACING A HALF SUNKEN GUN BATTERY UPON THE GROUND.

The half sunken gun battery being as it were a medium between the elevated and the sunken battery, its tracing partakes of the peculiarities of both. As in the elevated battery, the interior base lines and exterior berm lines both of the parapet and epaulments must be traced throughout the whole extent of the work, at parallel distances, determined by a reference to the profiles, but without regarding inches or fractions of a foot. And by the rule followed in respect to the sunken battery, the traverses must be traced and commenced at the same time with the battery itself, and the interior berm lines must also be marked, by the same rule. The extreme length of the interior base line of the parapet

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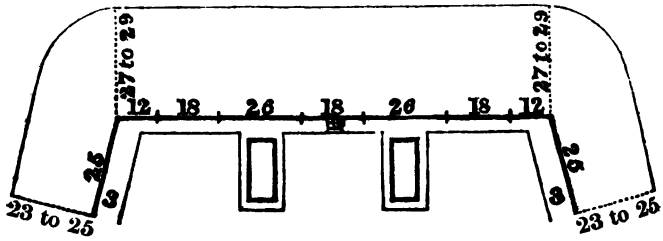
is also made greater than that of an elevated battery, by the same rule followed in respect to the sunken battery, and for the same reason.

The annexed figure represents the tracing of a half sunken battery for 6 guns, with 2 splinter proof traverses, and 2 epaulments.




In this tracing, as applied to a gabion or fascine battery, the interior base lines of the parapet, and epaulments, as well as the base lines of the two traverses are supposed to be marked by fascines, which are represented by thick lines in the figure, whilst all the other lines are supposed to be marked by tracing lines or white tape. The total length of the interior base line, which for an elevated battery of the same number of guns and traverses might be only 120 feet, has been made 130 feet, as in the sunken battery, but it might without inconvenience be reduced in the half sunken profile to 126 feet, by taking off one foot from the berm of each epaulment, and from each great merlon. The center of each embrasure is marked by a picket, but the cheeks are not traced, as in the sunken battery, because the embrasures commence at a greater height above the natural ground.

### 3. OF THE MODE OF REVETING THE PARAPET OF A HALF SUNKEN BATTERY.

*First.—Supposing that Gabions are to be used.*

The first course of fascines laid along the interior base line of the parapet, on the level of the original ground, being backed with earth, a second course of fascines is laid over it, and this when also backed with earth, will stand about 18 inches above the ground, which in addition to 2 feet the depth of the trench, will make 3 feet 6 inches in all; being the height proper for the sill of the embrasure; and when

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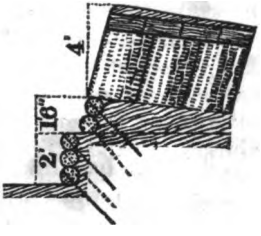
the earth thrown up, partly from the trench in rear, and partly from the ditch in front, shall be properly arranged from this level outwards, with a small dip towards the front, the solid of the parapet will be completed: after which, the embrasure, must be traced, either with or without a fascine to each cheek, which tracing and the subsequent reveting of the two cheeks, and of the back of the merlon with gabions, are done by precisely the same rules, as in the execution of an elevated gabion battery. (See Section II, Article 2.)

The annexed figure is the profile of part of a half sunken gun battery, explaining three particulars. The solid, shown in section, is raised 18 inches above the natural ground level, and 3 feet 6 inches above the sole of the trench, by a couple of courses of fascines. Part of the gabion revetment of the cheek of the embrasure is shown in elevation.




After the revetment of the upper part of the parapet of a half sunken battery is finished, the interior berm is cut away for the space of 12 feet, opposite to the center of each embrasure, which must be reveted with three vertical courses of fascines, as shown in the annexed figure, according to the rule before explained in Section IV, Article 5, in treating of sunken gun batteries.

*Secondly.—Supposing that Fascines only are used for the Revetments of the upper Part of the Parapet.*

In this case after proceeding in the manner that has just been described, until the solid is completed, the merlons are reveted by precisely the same rule as in an elevated gun battery.

The space of 12 feet under each embrasure is then reveted by 3 vertical courses of fascines, in the usual manner, after cutting away the berm,

*Thirdly.—Supposing that Sand Bags only are used for the Revetments of the upper part of the Parapet.*

In this case the revetment being commenced on the natural ground, is raised by three courses of sand bags, to the height of 18 inches above that level, which will complete the solid as was before explained. The embrasures must then be traced, and the merlons finished by precisely the same rule, as in an elevated sand bag battery.

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The space of 12 feet under each embrasure is then reveted by three vertical courses of fascines, in the usual manner, after cutting away the berm.

4. OF THE QUANTITY OF REVETING MATERIALS REQUIRED FOR A HALF SUNKEN GUN BATTERY.

*First.—When Gabions or Fascines are used.*

The quantity of materials is the same as in a sunken gun battery, or nearly so, but with this trifling difference in the arrangement, that one course of fascines more goes to the upper portion, and one course of fascines less to the lower portion of the revetment of the parapet of a half sunken gabion or fascine gun battery, than of a sunken gun battery of the same description.

*Secondly.—When Sand Bags are used.*

In respect to sand bag batteries, the like near approximation to the same quantity of materials in those two profiles takes place, inasmuch as the half sunken profile requires two courses of sand bags more in the upper portion, and one course of fascines less in the lower portion of the revetment, than the sunken profile.

Hence the half sunken sand bag battery requires about 30 sand bags more, and one fascine less, than the sunken sand bag battery, for each regular one gun portion of the parapet.

The like very trifling difference takes place in the revetments of the traverses of these two kinds of batteries.

This being explained, it appears superfluous to go into further details in respect to the subject of this article, in estimating which, you may refer to section IV, articles 11 and 12

5.—OF THE QUANTITY OF LABOUR, NUMBER OF WORKMEN, AND TIME, NECESSARY FOR THE EXECUTION OF A HALF SUNKEN BATTERY.

*First.—Quantity of Labour.*

The quantity of excavation, necessary to furnish earth for completing a regular one gun portion of the parapet of a sunken battery, is about 40 cubic yards.

*Secondly.—Number of Workmen.*

In every regular one gun portion of the parapet, 4 diggers may be employed in the ditch in front, 4 diggers in the trench in rear, 4 shovellers, and 2 rammers, making 14 labourers in all, which number is sufficient for the execution of a gabion battery.

In a fascine battery, to the above number of labourers, add 2 builders, making 16 workmen in all.

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In a sand bag battery, to the same number of labourers, add 2 builders, 2 fillers, and 3 carriers, making 21 workmen in all.

*Thirdly.—Time.*

There being 8 diggers to excavate 40 cubic yards, in the half sunken battery, and all of them having room to work conveniently in the space of 18 feet allowed to a regular one gun portion of the parapet; one might reasonably anticipate, that the half sunken battery ought to be finished by its two rows of diggers, who have a task of only 5 cubic yards per man, in little more than one half of the time required for the execution of a sunken battery by its one row of diggers, each of whom has a task of 8¼ cubic yards to execute.

The above expectation, which was confidently entertained by us, before the question was submitted to the test of repeated experiment, has not been borne out by the practice of this establishment; for our half sunken batteries, although double manned with diggers, have seldom been finished much sooner than our common sunken batteries.

This again confirms the maxim, often before repeated, but which ought never to be lost sight of, in conducting the practical operations of a siege; namely, that the increase of the number of workmen beyond a certain limit, is never attended with a proportionate increase of the quantity of work, that will be performed by the greater number, in any given time.

## SECTION VI.

### OF GUN PLATFORMS.

1. THAT PLATFORMS ARE ABSOLUTELY NECESSARY FOR SIEGE BATTERIES. GENERAL DESCRIPTION OF SPLAYED GUN PLATFORMS. OF THE RISE PROPER FOR A GUN PLATFORM.

All heavy guns, such as are used in a siege, require substantial wooden platforms to be laid for receiving them, without which their great weight would cause the wheels or trucks of the carriages on which they are mounted, to sink into the ground, so that after having recoiled and been run up again once or twice, they would become nearly, if not absolutely unmanageable. The platforms, by distributing

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their great weight over a larger surface, prevents this inconvenience, and renders it practicable for a few men to execute all the necessary movements of the gun.

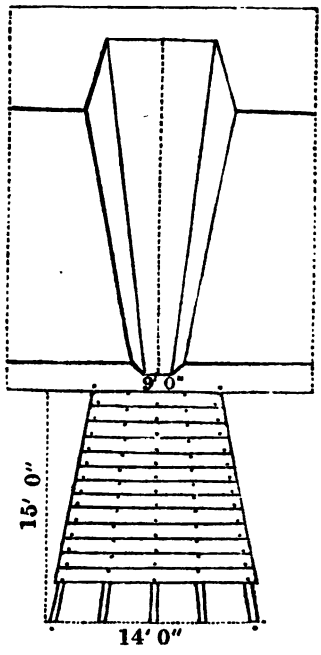
Some years ago we used to make all our platforms 15 feet long, 9 feet wide in front, and 14 feet wide in rear, thus giving to the sides a splay, as it is technically termed, by causing them to diverge to the rear.

Gun platforms are composed of planks resting upon sleepers. The latter, which may be four or five in number, are laid longitudinally from front to rear, and are sunk into the ground, from which circumstance they derive their name. The planks are of course laid transversly over the sleepers.

It was formerly the invariable custom in the British service, to spike the planks down upon the sleepers.

Gun platforms are always laid immediately in rear of their respective embrasures, the object line of the latter being also the central line of the former, so that when a platform has five sleepers, the center one is laid in the direct prolongation of the object line of the embrasure, produced towards the rear,

The annexed figure represents one of the splayed platforms of our old pattern, supposed to be connected by means of spikes. The rear part is left in an unfinished state, to show the position of the five sleepers which are laid with a splay to suit the form of the platform, the centre sleeper only being perpendicular to the parapet. The spikes are not driven through or into the center of each plank and sleeper, but alternately towards contrary sides, to prevent them from splitting the wood, according to the rule followed in fixing the boards to the bridging joists of floors.




The length of the spikes proper for gun platforms evidently depends upon the thickness of the planks and scantling

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of the sleepers, which they are to connect. If they be able to pierce the latter to the depth of 3 or 4 inches, after passing entirely through the former, it will be sufficient.

The slope, at which platforms are laid, has been repeatedly noticed, in the preceding parts of this Essay. It is so far disadvantageous, that it diminishes the cover afforded by the parapet to the gunners, when standing on the tail of the platform, and it should not therefore be made greater, than is absolutely necessary to check the recoil, and to facilitate the running up of the gun. For this purpose a rise of half an inch per foot, or of 1 in 24 is considered sufficient; for on a slope of this description, the average recoil of a 24-pounder mounted on a travelling carriage, and fired with the full service charge of 8lbs. of gunpowder, does not exceed 7 feet. It is true, that in consequence of the gun carriage itself being about 14 feet long, the trail of the carriage runs entirely off from the platform, at the period of the recoil; but this is attended with little or no inconvenience, for the wheels, which bear the whole weight of the gun, stand nearly on the middle of the platform after the recoil; and the trail itself is too light to give any trouble by sinking into the ground. If it did, one or two loose planks may be laid for it to run upon.

The above slope also enables the gunners to run up the gun after the recoil, with very little labour. Formerly we used to allow more, but our practice in the summer of 1829, with an iron 24-pounder 9 feet gun, fired with shot and with the full service charge of powder, has satisfied us, that a greater rise would be useless.

To prevent the wheels of the carriage from injuring the revetment of the parapet, when the gun is run up, *a Hurter* has usually been recommended, which is a piece of timber about 9 inches square, extending along the front of the platform, close to the foot of the interior slope. The hurter instead of being laid upon one of the planks, may rest upon the front of the sleepers, laying the first plank in rear of

it, as shown in the annexed figure, which is a profile of a finished gun battery, with a platform of the above description complete.

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2. THAT SPLAYED PLATFORMS ARE INCONVENIENT FOR SIEGE BATTERIES. DESCRIPTION OF THE OLD RECTANGULAR GUN PLATFORM, USED IN THE BRITISH SERVICE. THAT IT WAS UNNECESSARILY LARGE AND UNWIELDY. OF THE MORE MODERATE DIMENSIONS, THAT ARE PROPER FOR FIELD SERVICE.

The splayed platform before described, if lengthened 2 or 3 feet, which would render it still more convenient, would be good for fortresses; as it admits of a gun traversing considerably to the right or left; and the method of connecting the parts by spikes is certainly the best adapted for permanent purposes; but neither the above form nor mode of connection are suited for siege batteries.

In the first place a great splay is unnecessary, for the guns of the besiegers' batteries are directed against particular works, which usually subtend so very small an angle, in reference to the distance, that they do not deviate on an average much more than 1 foot in 12 from the object line, or center line of the embrasure. But the splay is not merely unnecessary; it is exceedingly inconvenient as applied to the platforms of a siege battery; for as all the planks are of unequal lengths, they require to be assorted and marked with numbers: and in working with more than one platform at a time, which we frequently did at this establishment, and which must always be necessary in a siege; the planks of several platforms are liable to get intermixed, which may occasion much trouble.

We therefore determined to adopt a rectangular platform for the practice of this establishment in future, after having commenced with the splayed platforms.

The rectangular gun platform had previously been long established in the British service, as an article of store, and platforms of that description had been sent out on all our expeditions during the late wars. The pattern, which may probably have been adopted from the time of the American war or earlier, was 14 feet wide and 18 or 20 feet long, and was composed of 5 sleepers of fir timber, each 9 inches square, and of 20 fir planks, each 1 foot wide, and 3 inches thick.

The above certainly makes a fine substantial gun platform when once laid, and connected by the spikes, which were invariably used with it. But its superfluous size, and enormous weight, rendered it so very inconvenient on service, that the officers of engineers, employed in the Peninsular

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war, generally reduced the platforms of this description to a smaller size, before they used them in their sieges; for the parts were so extremely unwieldy, that not merely the transport, but even the mere laying of them was attended with great difficulty.* At 34 lbs. to the cubic foot, which may be considered the average specific gravity of fir timber, each sleeper of 20 feet must have weighed at least 382 lbs., and each plank must have weighed about 118 lbs.; so that the whole weight of woodwork must have amounted to 38 cwt. 14 lbs. Such a platform is not well suited for field service.†

*Secondly.—Of the more moderate Dimensions of Gun Platform, that may be adopted for Siege Batteries.*

Setting aside the splayed platform as inconvenient, and the rectangular platform of the old pattern, that has just been described as too heavy, it will perhaps be allowed on due consideration, that a gun platform of 9 feet in clear width, and of 14 feet in length, is the smallest, that can possibly answer the purpose: but that one of the moderate size of 10 by 15 feet need scarcely be much exceeded.

The width of a gun platform must entirely depend upon the degree of obliquity, at which the gun requires to be fired. Now the space subtended by the face of a bastion, or any other work, against which a particular battery is directed, if compared with the usual distance of the first batteries in a siege, will scarcely ever require the gun to be traversed more than 1 foot in 12 to the right or left of the object line of the embrasure. This very moderate divergency may be provided for by the least of the above-mentioned widths.

The length of a gun platform must of course be regulated by the recoil of the gun, which depends partly upon the charge, and partly upon the rise or steepness of the inclined plane, that the carriage has to ascend in this motion. In a platform of 14 feet in length, having a rise of half an inch in a foot, as before recommended, the wheels of the travelling carriage of a 24 pounder, fired with full charges of powder, will stand about 9 feet from the front, and 5

* See the article *Platforms*, in Note 16 of the first edition of Colonel Jones's Journals of the Sieges in Spain, in which he states that those Platforms could not be laid under fire.

† The respective weights of the Gun platform of the new pattern described in pages 135 and 262, and of the triangular Field Powder Magazine timbers in pages 179 and 180, and also of the new Field Traversing Gun Platform in page 270, were obtained by actual weighing, and in some cases, the fir being of superior quality exceeded the above average specific gravity. The weight of most of the other platforms, &c. stated, were not weighed, but estimated, the fir at 34 lbs. and the oak at 50 lbs. to the cubic foot.

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feet from the rear of the platform, after the recoil. It does not seem desirable, that the space in rear should be less than the last named dimension, and therefore 14 feet has been assumed as the minimum length of platform proper.

*Thirdly.—Scantling proper for the Sleepers of a Gun Platform.*

In respect to the wood work, it will be recollected, that the sleepers and planks are not like the joists and boards of a floor, unsupported between their extreme bearings, but both are aided by the ground, into or upon which, the former are bedded, and the latter rest. The sleepers, therefore, require no farther strength than to prevent them from bending under the weight of the gun, owing to any inequality in the solidity of the earth below. A scantling of 5 inches square will be quite strong enough for this purpose.

*Fourthly.—Thickness proper for the planks.*

Sound fir planks of 2 inches in thickness, when laid as part of the superstructure of a military bridge, at intervals or bearings of about 2½ feet, are capable of supporting the weight of a 24-pounder mounted on a travelling carriage. Indeed, I conceive that in consideration of the aid which a platform derives from the ground, on which it rests, planks of 1¾ inch in thickness, having sound earth well rammed beneath them might answer the purpose: but considering further, that it is desirable to use the same gun platforms, or at least the parts belonging to them, more than once in a siege, by moving them forward from the first to the advanced batteries, and that the planks must necessarily be worn thinner by use, in the course of the firing; it may perhaps be most prudent to make all the platform planks full 2 inches in thickness, or even a little more in order to allow for wear and tear.

In inland operations, if the gun platforms should require to be moved, even to a moderate distance by land carriage, it must be evident that the saving of weight is an object of importance. This consideration must have some influence in deciding upon the size of the platform, and the scantling or thickness of the woodwork, of which it is composed.

When planks of the proper thickness are not to be had, thinner planks doubled will answer the purpose.*

* Two thicknesses of 1¼ inch flooring boards obtained from an unfinished house, were used for all our gun platforms on the extreme right, in the attack of Copenhagen, in 1807, which proved efficient and serviceable, although they creaked in such a manner under the recoil of the guns, that when the first volley was fired, it was supposed for the moment, that they had been split, or broken by the weight.

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### 3. THAT SPIKED PLATFORMS ARE INCONVENIENT FOR SIEGE BATTERIES. OF THE MEANS FOR DOING AWAY, PARTIALLY OR ENTIRELY, WITH THE USE OF SPIKES.

It was before observed, that the spiked platform, although the most solid and proper for permanent purposes is inconvenient in the field. The chief objection to it is, that it cannot be taken to pieces wholly or even partially, without being much injured in separating the planks from the sleepers. Hence it is difficult of repair, if damaged by a shell, and it it can scarcely be taken up and laid again in a new position, without being so much shattered in drawing the spikes, as to be unserviceable, or nearly so. Much time also is required in laying, repairing, or removing a platform connected by this method. Upon the whole, spiked platforms should never be used for siege batteries.

To get rid of these difficulties, in part, or entirely, the following expedients were successively adopted.

*First. To spike the Planks only to the two outside Sleepers.*

This arrangement saved more than half the number of spikes before used.

*Secondly. To secure the Platform by a couple of Ribbands and spikes,*

Ribbands are pieces of wood resembling the sleepers, and of the same length, but which may be of rather weaker scantling. These being laid upon the ends of the planks, along each side of the platform, exactly over the two extreme sleepers, and being connected to these sleepers by long spikes driven also through the intermediate planks will of course serve to confine the whole platform, and to prevent the parts of it from separating; so much so, that the planks need not be spiked to any of the other sleepers excepting those two.*

*Thirdly. To secure the Platform by a couple of Ribbands, with screw bolts and nuts.*

In this case the ribbands may be nearly equal to the sleepers in scantling. Being laid over the ends of the planks on each side of the platform, as before stated, they are made fast, to the extreme sleepers below, by iron screw-bolts and nuts, passing through all. The annexed figure is the transverse section of a platform thus secured, showing 5 sleepers,

* This arrangement was followed in respect to the double boarded gun platforms, used at Copenhagen, as described in the note to the preceding article.



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bedded in the ground, a platform plank resting upon them, and the two ribbands over all, at the sides of the plat-

form. The iron bolts are pushed through the extreme sleepers from the bottom upwards, when these are first laid, and have their heads undermost, and the nuts at top. The latter of course are not screwed on, until after the whole platform is laid, and the ribbands fitted in their proper places.

About 4 screw bolts and nuts may suffice for each ribband, for it would be inconvenient to use more; and a smaller number would scarcely confine the parts of the platform together, in a manner sufficiently firm.

Screw bolts used for this purpose should be three-quarters of an inch in diameter, and without including the head, they should be about 1½ inch longer than the depth of the ribband, and sleeper, and thickness of the plank added together, in order to allow room enough for a nut.

This method, which we used at this establishment for many years, and which had, I believe, been often previously used on service, is a great improvement upon the former arrangements, and is very good, when the platform is first prepared, with the iron work in good order, and when all the parts fit well: but we found after repeated use, that the bolt holes could not be got to fit accurately, so that it was necessary to cut them larger, and the screws got out of order; and the whole arrangement proved very troublesome.

*Fourthly.—To use Screws instead of spikes, but without Ribbands.*

This is a very good method, and has a great advantage over spikes, inasmuch as the parts of the platform are no less firmly connected, and may be taken to pieces by drawing the screws with very little injury to the woodwork. But this arrangement takes up more time than any other.

*Fifthly.—To use Ribbands and Racklashings.*

Recently we adopted the expedient of racking down the sides of our platforms, like the superstructure of a pontoon bridge; which was found perfectly efficient, and much more convenient in every respect, than our former arrangements.

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4. THAT THE RECOIL IS SO INSIGNIFICANT IN RICOCHET FIRING, THAT LESS RISE THAN USUAL IS NECESSARY, AND THAT REGULAR PLATFORMS MIGHT EVEN BE DISPENSED WITH.

The recoil of a gun, throwing a shot of a given weight, must evidently depend upon the quantity of powder, at least up to a certain limit; and so it has been found in practice. In ricochet firing with an iron 9 feet 24-pounder, the charge proper for a range of 600 yards is rather less than 1 lb. and even at the greatest ranges that are ever likely to be used in a siege, it would not exceed 2 lbs. Both of these quantities of powder, but especially the former, which is only one-eighth part of the full service charge, produce so very small a recoil, that a much less rise than that of half an inch per foot, would suffice for the platforms of a gun battery, intended for this kind of firing exclusively. Indeed, in this case, a regular platform might often be dispensed with, for unless the soil were of a swampy nature, a couple of stout planks under the wheels might suffice.

But as it is not prudent to reckon upon confining ones' self to ricochet firing alone, in any battery, to the entire exclusion of direct firing with full charges, it is proper to provide regular platforms suited to both: for it would be a very awkward thing, if the battery when unexpectedly required to fire with the full charges, should suddenly be obliged to cease firing, when warmly engaged, in opposition to the enemy's guns, owing to the loose planks, or other slight substitute for regular platforms giving way.*

5. DESCRIPTION OF THE NEW SIEGE GUN PLATFORM, RECENTLY ADOPTED AT THIS ESTABLISHMENT.* NUMBER OF MEN NECESSARY FOR CARRYING IT, &c.

*First.—General Dimensions of the Platform.*

Fifteen feet long, and 10 feet 6 inches wide, which is reduced by the use of ribbands, to the clear width of about 9 feet 10 inches only.

*Secondly.—The Sleepers.*

Fifteen feet long, and 5 inches square. The arrises must

* The first gun platforms I ever laid upon service, in a 24-pounder battery, were prepared according to the directions received from a senior Engineer Officer, by connecting a few planks together, in the manner recommended by a German Author. To our surprise and disappointment, after a few rounds had been fired, with full charges, all these platforms gave way, and as this happened towards evening, the whole of the night was taken up in preparing regular platforms of a more substantial description.

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be taken off, and the ends chamfered, for about a quarter of an inch on each side, to prevent them from splitting, if thrown carelessly down. They should be tarred, as they are always buried in the ground.

*Thirdly.—The Planks.*

Ten feet 6 inches long, 2 inches thick, and 9 inches wide. Each plank should be gauged to the above width, and its edges shot square, after which the arrises must be taken off, This is of considerable importance, as every plank may thus serve the purpose of a straight edge, in laying the platform. They are notched for about 6 inches from both ends, but on one side only, by making these extreme portions of each plank one inch narrower. Two half inch iron bolts should be driven through the full width of every plank, near to, but within the shoulders of the above notches, that is about 10 inches from the extreme ends. The center of each plank is marked in a conspicuous manner, by notching the two edges about a quarter of an inch deep. The annexed figure, which is the plan of a gun platform plank, explains the above particulars.

When the wood is well seasoned, another mode of preventing the planks from splitting, may be used in preference to the former, both having been adopted by us at Chatham. This consists in making up some pieces of 1½ inch hoop iron, into rectangular hoops just suited to the ends of the planks, which are notched all round to receive them. These hoops are fixed whilst hot, and secured by eight nails to each. Sometimes we used a third hoop, which served to mark the center of the plank. The joints of all these hoops must be upon one edge, instead of resting on the top or bottom of the plank. The second figure annexed represents a platform plank thus hooped.

In respect to the width of our planks, 9 inches was adopted rather than 1 foot, merely because the former is the width of common deals, whereas the latter dimension requires the planks to be sawn out of large timber.

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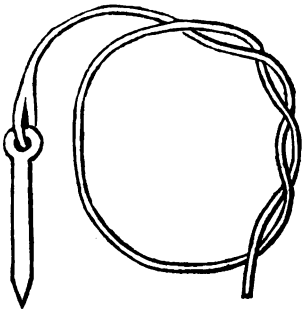
*Fifthly.—Of the substitute for a Hurter.*

We found in our gun practice of 1829, that a 9-feet fascine answered the purpose of a regular hurter, and being a much simpler expedient, it was acknowledged to be preferable.

*Sixthly.—Of the rack lashings and rack sticks.*

The rack stick is 15 inches long, and two inches wide at the head, through which a hole of $\frac{3}{4}$ of an inch in diameter is bored to receive the lashing. At this part it is $1\frac{1}{2}$ inch thick. Below the eye, it is round, and tapers a little towards the point, which is rather blunt.



The rack lashing is of 2-inch rope, and 8 feet 6 inches in extreme length, which is reduced to about 8 feet by passing one end through the hole at the head of the rack stick, and forming an eyesplice with it, as shown in the annexed figure.

*Seventhly.—Detail and weight of the parts of the above Platform.*

| | CWT. | QRS. | LBS. |
|---|---|---|---|
| 5 Sleepers 15 feet long, and 5 inches square, at 101 lbs. . . . . | 4 | 2 | 1 |
| 20 Planks, $10\frac{1}{2}$ feet long, 9 inches in average width, and 2 inches thick, at $44\frac{1}{2}$ lbs. . . . . | 7 | 3 | 22 |
| 2 Ribbands, 15 feet long, and 4 inches square. at 65 lbs. . . . . | 1 | 0 | 18 |
| 10 Racksticks and lashings at 1 lb. . | | | 10 |
| Total Cwt. . . | 13 | 2 | 23 |

*Eighthly.—Number of Men necessary for carrying the above Platform.*

Allowing 2 men for each sleeper, and 1 man for each plank and ribband, 32 men will carry the whole platform. A non-commissioned officer may carry the rack sticks.

REMARKS. The above appears to be the simplest kind of gun platform that can be used, for as every plank is alike, and all the parts are wieldy and manageable, and can be taken to pieces quickly, no confusion can arise from a mix-

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ture of the materials of several platforms; and partial repairs, well as complete removal, are rendered equally easy.

There are two other kinds of gun platforms, namely, the Madras platform, and the Austrian platform, that have been contrived for the purpose of saving timber, and consequently weight; the former of which is particularly ingenious. Both of these will be described hereafter, in treating of the varieties that may take place in the construction of batteries, and of their component parts.

### 6. ESTIMATE OF MEN, TOOLS, AND IMPLEMENTS, FOR LAYING A SIEGE GUN PLATFORM OF THE NEW PATTERN. EXECUTION OF THE WORK, AND TIME.

*First.—Estimate of Men, Tools, and Implements.*

| | |
|---|---|
| 4 Men. | 1 Six feet rod. |
| 4 Pickaxes. | 1 Maul. |
| 4 Shovels. | ½ of a bundle of pickets (6 in number). |
| 1 Field level. | |

Before the men told off for this duty commence to lay the platform, they must be particularly cautioned, not to cut or injure the sleepers by their pickaxes or shovels, whilst bedding them in the ground, or whilst taking them up afterwards, which otherwise will be sure to happen, either from awkwardness or over-eagerness. At this establishment, the non-commissioned officer in charge of the stores has directions to examine all the parts of each platform, before they are issued, and after they are received back into store, and to report upon them if damaged.*

*Secondly.—Execution of the Work.*

The center sleeper and the two outside sleepers may be placed by means of the field level used as a square, and of the 6 feet rod, laying the center sleeper in the direct prolongation of the object line of the embrasure, and consequently at right angles to the parapet, and laying the latter parallel to and equidistant from the center sleeper, so that these two extreme sleepers shall cover the proper space of 10 feet 6 inches in width from out to out, which is of course done by measuring 5 feet 3 inches on each side of the center.

The same object may however be effected in a more convenient manner, by using two platform planks as temporary

* The parts of the first platforms used in the practice of this establishment became shapeless masses, from being injured in this manner, long before the wood decayed; which suggested the necessity of the above precaution. The men are now checked if the platforms are injured through neglect.

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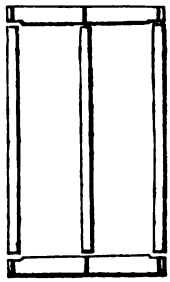
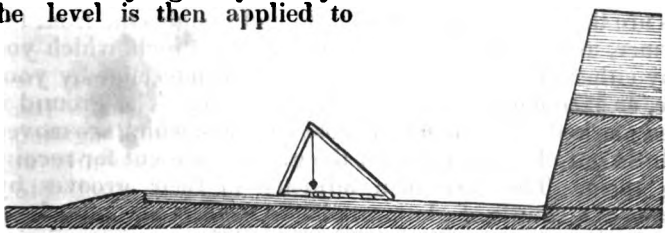
gauges, for determining the positions of those three sleepers. This is done by placing one of these planks close to the interior base line of the parapet, with its center immediately under the middle of the embrasure. The center sleeper is then laid close in rear of and at right angles to it, which is done by using the field level as a square, and causing the center of the sleeper to agree with the center of the plank. The center of the second plank is then applied to the rear of the sleeper, so as to lay this plank parallel to the former and with the center of each in the direct prolongation of the object line of the embrasure. The two outside sleepers are then placed parallel to the center sleeper, by laying them flush with the extreme ends of the planks, on each side, as shown in the annexed figure.



The ground, close to each side of the three sleepers, is then marked by a pickaxe or shovel, to show the sides of the grooves that must be prepared for receiving them. The sleepers are then turned over to one side, and the front plank removed, until the grooves are cut, which must be made full 5 inches deep towards the front, but diminishing to nothing in rear, if the natural ground be level or nearly so. The center sleeper must be placed in its proper groove when ready for receiving it, laying it with a rise of about half an inch per foot, as nearly as can be judged by the eye.

The level is then applied to



the top of it, as shown in the annexed figure, which is a longitudinal section of the platform, and the sleeper is adjusted by giving it more or less slope as may be required, until the plummet stands over that particular line of all the diverging lines upon the lower limb of the instrument, which is marked 1 in 25, this slope being the nearest, and a sufficient approximation, to half an inch per foot. The adjustment of the sleeper is effected by a little loose earth, taken from or added to any part of the groove.

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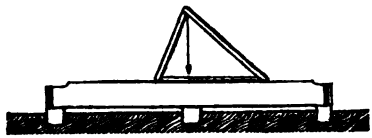
The two outside sleepers are laid next in their respective grooves, parallel to the former, and at the same slope, which is done by bringing the ends of these two sleepers to the same horizontal level with the corresponding ends of the centre one, by levelling transversely first in front, and afterwards in rear. For this purpose any of the platform planks may be used as a straight edge, by laying it across the extreme ends of the three sleepers, with its notched side uppermost, and then applying the level to the top of it, as shown in the annexed figure, which is a transverse section of the platform in progress. One or both of the extreme sleepers must now be moved by raising or lowering its end, until the upper surface of both shall be in the same plane, with that of the center sleeper, whilst the plummet stands over the vertical line of the lower limb of the instrument, that denotes the horizontal level. Whilst the extreme sleepers are about to be definitively adjusted by this method, the rack lashings must be introduced under each, at the proper positions, to be in readiness for racking down. This is done by laying the rope under the sleeper, at right angles to it, with the rackstick and about 1½ foot of rope to the outside. After the two extreme sleepers as well as the center one are correctly laid by the above process, the two intermediate sleepers are then laid down, parallel to and equidistant from the former, at clear intervals of about 2 feet 1 inch, which you may either measure by the 6 feet rod, or determine by your eye, as extreme accuracy is not necessary. The ground is then marked on each side of those sleepers, which are moved a little out of the way, until the grooves are cut for receiving them. They are then adjusted in their grooves by means of a couple of platform planks, used as straight edges, and applied transversely as before, until they are brought into the same plane with the three first laid sleepers, in which operation, it is unnecessary to have further recourse to the level.



When the whole of the sleepers are thus placed, they must have the earth about them, and especially towards the rear, made good to the level of their upper surface, or nearly so. The planks must then be laid transversely across the sleepers, and flush at the ends with the outside ones, until

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the whole area of the platform is covered: and lastly, the ribbands must be laid upon the sides of the platform, over the extreme ends of all the planks, and racked down by means of the rack sticks and lashings.

In racking down, the end of the rack lashing is passed twice round the standing part of the same rope, about a foot from the rack stick, and thus an open overhand knot is formed above the ribbands, of the nature represented in the figure of the rack stick and lashing, given in the preceding article *(Page* 135*)*. The point of the rack stick is then introduced into the bight of the rope, and is turned round repeatedly until the rope is twisted, and the size of the knot thereby diminished, in such a manner as to choke the ribband, and press it down as close over the sleeper as the intervening thickness of plank will permit. The stick is then jammed close to the outside of the ribband. When all the rack lashings are fixed by this method, the planks are well confined, and all the parts of the platform are connected into one compact body. Lastly five pickets are driven at equidistant intervals in rear of the platform, and pressing against the ends of the sleepers and planks.*

The method of determining the positions of the rack lashings shall now be explained, which was not done before, lest it should interrupt the description of the general operation of placing the sleepers. The first and fifth rack lashings are placed 18 inches from the ends of each of the two outside sleepers. The second, third, and fourth, are placed at equidistant intervals of 3 feet between these two. These distances are measured by the 6 feet rod, and marked on each of those two sleepers by chalk, in order that the places for the ropes, which are laid in the same grooves, under the sleepers, may not be lost and require remeasurement, during the repeated moving of the sleepers and ropes out of the grooves, which is usually necessary during the adjustment of the former.

To save trouble, the places for the 5 rack lashings may be marked by hoops of paint about one inch broad, on each of the ribbands, which may then be used as gauges for chalking the two outside sleepers, or for laying the ropes in the grooves prepared for those sleepers at once.

* We formerly used 20 pickets driven in pairs, on each side of the sleepers in front and rear: but this expedient recommended in all the former Authors on batteries is useless, the sleepers having no tendency to move laterally; but there is a slight tendency for the parts of the platform to move to the rear in the recoil of the gun, after continued firing, as we found by experience.

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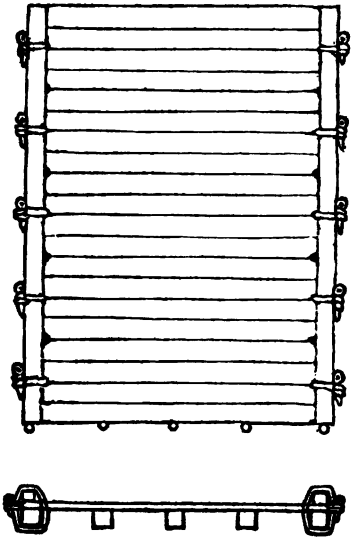
In laying the planks, it will be most convenient to cause the notched sides of those two, between which any of the rack lashings are to be used, to meet, although this arrangement is not absolutely necessary, otherwise we would have notched all our planks on both sides, instead of one.

The first of the annexed figures is a plan of the finished platform, showing the planks, as confined by the two ribbands, and by ten rack lashings, five on each side.



The second figure annexed is a transverse section of the platform, showing also the five sleepers, which did not appear in the plan, with the mode of connecting them with the ribbands, as far as it can be explained on so small a scale.

*Time.* — Expert men, who have practised this operation repeatedly, can lay a gun platform of the above description in the stiffest soil, in rather less than an hour,* and can completely dismantle it in three minutes.

## SECTION VI.

### RULES FOR THE CONSTRUCTION OF ELEVATED MORTAR BATTERIES.

#### 1. GENERAL REMARKS ON MORTAR BATTERIES.

The parapets of mortar batteries are always made solid throughout, it being quite unnecessary to make embrasures for the shells to pass through, as these are always fired from mortars at an angle of 45 degrees of elevation.

* More time by comparison is lost, through awkwardness and inexperience, in the laying of platforms, than in any other operation, practised at this Establishment.

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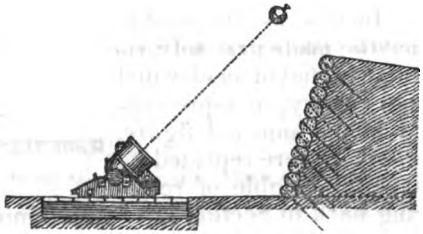
The height, thickness at top, and slopes, of the parapet and epaulments of mortar batteries, are regulated by the same rule nearly as those of gun batteries; so that the profile of the parapet of a mortar battery may be made similar to that of the solid portions of the parapet of a gun battery, that is according to a section taken through one of the merlons of the latter.

Mortars being placed on a bed, or strong block of wood or iron, lying flat on the platform, and being laid at a much greater elevation; the concussion in firing, forces the mortar bed obliquely downwards, with a much more violent action upon the woodwork of the platform, than in the firing of an equal charge from a gun, but with very little recoil, or movement to the rear. Consequently mortar platforms are laid perfectly horizontal, whilst gun platforms as before explained have a rise of 7 or 8 inches. Hence, in constructing a mortar battery, and a gun battery, under the same circumstances of position, against an enemy's works of equal command, it is not absolutely necessary, to make the parapet of the former quite so high, as that of the latter, the gunners being at times more exposed in a gun battery, than in a mortar battery of equal relief, owing to the different arrangement of their respective platforms.

It seems scarcely worth while, however, to make any great diminution in the height of the parapet of a mortar battery on this account. Six inches is the utmost, that could safely be allowed; but in our practice at Chatham, we have usually given to our mortar batteries whether elevated or sunken, the same height or total relief, as to our gun batteries of the same description.

When mortar batteries are reveted interiorly at the usual slope of one-fourth of the height, which all former writers on batteries have recommended, the front of the mortar platform must necessarily be placed at least 5 feet in rear of the base of the parapet, as shown in the annexed figure, which is the section of a mortar battery of the usual description, in order that the shells fired at the aforesaid angle of 45 degrees, shall be able to clear the crest of the parapet by about 3 feet; which evidently would not be possible, if the platform were placed close to the foot of the parapet, as in a gun battery.



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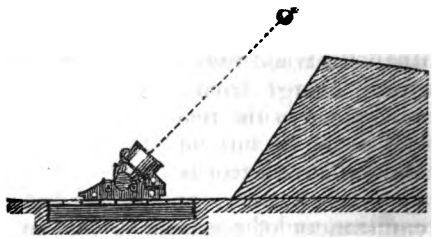
From the horizontal direction, in which guns are pointed, and from the violent action of the explosion of the powder, upon every thing immediately in front of the muzzle of the gun whilst being fired, it is absolutely necessary, that the interior of the parapets of gun batteries shall be reveted as perpendicularly as possible; in order to admit of the gun being run well out, into the broad part of the embrasure, where the effects of the explosion are less injurious. In a mortar battery, on the contrary, no such necessity of reveting the parapet exists; for the service of the mortars can be carried on equally well behind an unreveted parapet, such as is represented in the second figure annexed: and the gunners employed in working the mortars are equally well covered; because it is unnecessary to remove the front of the platforms to so great a distance in rear of the parapet, when the latter is formed with that greater degree of interior slope, which is proper for unreveted profiles.



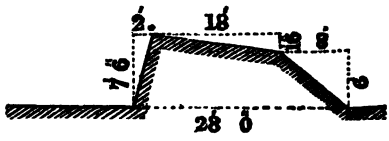
Upon the whole, the unreveted profile of the second figure appears to me to be the best suited for the first mortar batteries in siege, which are usually made at such a distance from the place, as to render it unnecessary to commence them by the flying sap.

When that operation is used, the parapet must of course be reveted in part, by the row of gabions, which are always employed in it, and which are sometimes crowned by one or more courses of fascines.

## 2. OF THE PROFILE PROPER FOR THE PARAPETS AND EPAULMENTS OF ELEVATED MORTAR BATTERIES.

*First.—Of the Profile of the Parapet when reveted.*

In this case the profile may be made precisely similar to that of an elevated gun battery, as represented in the annexed figure, which is here repeated, to save the trouble of referring back to Section I. Some diminution of the height, not

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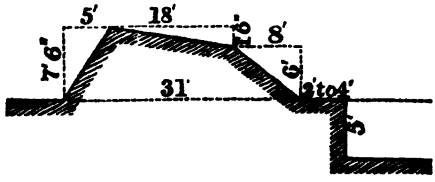
however exceeding 6 inches, might take place without impropriety, as was before observed.

*Secondly.—Of the Profile of the Parapet when unreveted.*

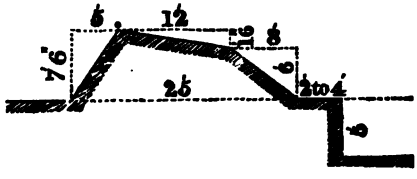
In this case, all other particulars remaining the same, the base of the interior slope of the parapet must be increased to about 5 feet instead of 2. This will increase the base of the whole parapet, in the like proportion, making it 31 feet in all, which is greater by 3 feet than that of the gun battery.

The annexed figure is the profile of the parapet of an unreveted elevated mortar battery, of this description. It will be observed, that according to this profile, the parallel dist ance between the interior base line, and the exterior berm line of the parapet will vary from 33 to 35 feet, allowing the usual berm of from 2 to 4 feet, according to the nature of the soil.




*Thirdly.—Of the Profile of the Epaulments.*

Precisely the same as those of an elevated battery, as represented in the annexed figure, which is here repeated, to save the necessity of referring back to Section I.




### 3.—RULES FOR TRACING AN ELEVATED MORTAR BATTERY ON THE GROUND.

The same rule nearly is followed as in tracing an elevated gun battery, but with this difference, that the smaller space of 15 feet per mortar is allowed; and as there are no merlons, the extremities of each one-mortar-portion of the parapet are marked on the interior base line, and not the centre of each subdivision of the parapet, as in a gun battery. The additional length of parapet allowed to each splinter proof traverse is alike in both, being made equal to the width of the traverse at the base, which need scarcely exceed 6 feet for a common traverse.

The annexed figure represents the tracing of an elevated mortar battery, for 6 mortars, with 2 splinter proof traverses, one between every two mortars, and 2 epaulments, the tra-

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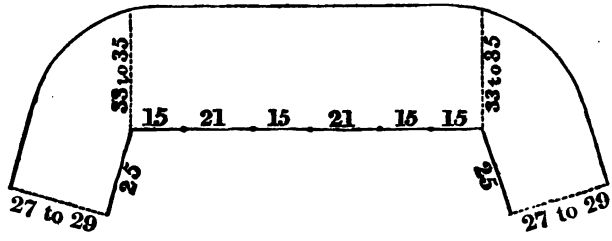
verses each being supposed to measure 6 feet at the base. Hence the total length of the interior base line of the parapet will be 102 feet, according to the following detail:

| | |
|---|---|
| 6 Mortars at 15 feet each ..... | 90 |
| 2 Traverses at 6 feet each ..... | 12 |
| Total | 102 |

Instead of marking the additional space for each traverse separately, on the interior base line of the parapet, it will be most convenient, to add it to one of the adjacent one-mortar-portions of the parapet. Hence the spaces marked out successively on the base line of the parapet will be as follows: 1st, a one-mortar-portion 15 feet; 2nd, a one-mortar-portion of 15, followed by a traverse of 6 feet, total 21 feet; 3rd, a one mortar-portion of 15 feet; 4th, a one-mortar-portion followed by a traverse as before, 21 feet; 5th, a one-mortar-portion of 15 feet; 6th, a one-mortar-portion of 15 feet, being the last.




The epaulments are traced by precisely the same rule as those of an elevated gun battery, and cover the same width at the base, of from 27 to 29 feet, including the berm, according as the soil may be stiff or loose.

If supposed to be reveted, the parapet also would cover the same space of ground as that of an elevated gun battery, but as we shall suppose the parapet of the mortar battery represented in our present figure not to be reveted, it must necessarily cover the greater space of from 33 to 35 feet. berm included, according as the soil may be stiff or loose. *(See the second Profile of the preceding article.)*

### 4.—OF THE QUANTITY OF LABOUR, NECESSARY FOR THE EXECUTION OF AN UNREVETED ELEVATED MORTAR BATTERY.

The profile of the parapet of an unreveted elevated mor-

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tar battery measures 164⅓ superficial feet, so that in each running foot of parapet, there are about 6$\frac{1}{11}$ cubic yards.

Hence in 15 feet, being the regular or common one-mortar-portion of the parapet, there are 91⅔ cubic yards.

Hence also in a great portion measuring 21 feet, which includes the space of 6 feet for a traverse, in addition to one mortar, there are 127⅞ cubic yards; and so on, in proportion.

### 5.—OF THE NUMBER OF WORKMEN NECESSARY FOR THE EXECUTION OF AN ELEVATED MORTAR BATTERY.

*First.—Number of labourers for a regular one-mortar portion of the parapet.*

*In easy Soil.*—In the first relief, 4 diggers, 3 shovellers, 2 rammers, total 9 labourers.

In the second and remaining reliefs add 3 or 4 shovellers more, total 12 or 13 labourers.

*In difficult Soil.*—In the first relief, 6 or 7 diggers in two rows, 3 shovellers, and 2 rammers, total 11 or 12 labourers, and the same number must be employed in all the remaining reliefs, excepting that 2 or 3 of the diggers must become shovellers.

*Secondly.—Additional Workmen necessary as Builders, when the Parapet is Reveted.*

In an elevated gabion mortar battery none are required.

In an elevated fascine mortar battery, add 1 builder extra, to be occasionally assisted by one of the labourers, of the former detail, per mortar, if necessary, who should of course either be a rammer or a shoveller.

In an elevated sand bag mortar battery add 2 builders, and 3 builders' assistants per mortar.

REMARKS.—The above number of labourers per mortar and epaulment, are precisely the same, as were before recommended for each gun and epaulment of an elevated gun battery, in easy and in stiff soil, respectively; but the builders per mortar, in the reveted profile are fewer, as there are no embrasures to be reveted in this kind of battery. The 4 diggers in the ditch of a mortar battery having only the space of 15 feet to work in, which is at the rate of 3 feet 9 inches per man, are more crowded than one could wish at the commencement of the work, but it is so great an advantage to have the same detail for each corresponding portion of an elevated mortar battery, and of an elevated gun battery, that it did not seem advisable to make any difference. After the excavation is extended to the width of four or five feet, the diggers will be able to work with more freedom.



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When diggers are employed in such close order, as in the ditch of a mortar battery, they should all be directed to front the same way in picking, which will prevent them from interfering with each other.

### 6.—OF THE TIME NECESSARY FOR THE EXECUTION OF AN UNREVETED ELEVATED MORTAR BATTERY.

The four diggers employed in a regular one-mortar portion of the parapet have to furnish 91⅔ cubic yards of earth, which is at the rate of 22$\frac{11}{12}$ cubic yards per man; whilst the 5 diggers employed in one of the supposed great portions of 21 feet, have to furnish 127$\frac{7}{9}$ cubic yards of earth, which is at the rate of 25$\frac{5}{9}$ cubic yards per man. Hence the task of the diggers in the ditch of the parapet of an unreveted elevated mortar battery exceeds that of the diggers of an elevated gun battery, by nearly 3$\frac{1}{3}$ cubic yards per man, in each regular one-mortar and one-gun portion: but the excess is of course rather less in the great portions of the former, as compared with the great merlons of the latter.

It is further to be observed, in comparing these two batteries, that the labour of the parapet of a mortar battery goes on regularly, without being impeded by the tracing of embrasures, or by the building of their cheeks, as in a gun battery.

Hence, we have found in the practice of this establishment, that our elevated mortar batteries, built according to the above profile, have generally been finished in from 13 to 14 hours of actual labour, in easy soil, and in from 24 to 25 hours, in the most difficult soil, that was to be met with.

### 7. OF THE QUANTITY OF LABOUR, MATERIALS, AND TIME, NECESSARY FOR THE EXECUTION OF A REVETED ELEVATED MORTAR BATTERY.

*First.—Of the quantity of Labour.*

The profile of the parapet of a reveted mortar battery measures 153 superficial feet, from which some little deduction may be made for the thickness of the reveting materials. Accordingly it may be assumed that in each running foot of parapet there are about 5$\frac{1}{2}$ cubic yards.

Hence in 15 feet, being the regular one-mortar portion of the parapet, there are 82$\frac{1}{2}$ cubic yards. And in a great portion measuring 21 feet, and including the space for one mortar and a 6 feet traverse, there are 115$\frac{1}{2}$ cubic yards.

*Secondly. Of the quantity of Materials necessary when the Parapet is chiefly reveted with Gabions.*

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For each regular one mortar portion of the parapet, 15 gabions, 2 fascines, and half a bundle of pickets.

For each great portion of 21 feet, 21 gabions, 3 fascines, and three quarters of a bundle of pickets.

*Thirdly. Of the quantity of Materials, when the Battery is entirely reveted with Fascines.*

For each regular one mortar portion 8, or 9 fascines.

And for each great portion 10 or 11 fascines, with pickets in the proportion of one bundle to four fascines.

*Fourthly. Of the Time necessary for completing a Reveted Elevated Mortar Battery.*

We have not made any batteries of this description lately, but as the quantity of earth to be furnished by each of the diggers for the parapet of a reveted mortar battery is at the rate of 20½ cubic yards per man, in each one-mortar portion and at the rate of 22 cubic yards per man in each great portion of the parapet, being less by about 2 cubic yards and a half, per man, than that required for the unreveted profile; the former may reasonably be expected to be finished in less time than the latter; probably in easy soil in 12 hours, and in very difficult soil in 23 hours, of actual labour, by good workmen.

8. OF THE TASKS PROPER FOR EACH RELIEF OF WORKMEN, IN THE EXECUTION OF AN UNREVETED ELEVATED MORTAR BATTERY IN EASY SOIL.

*First.—In the execution of the Parapet.*

*Task of the first Relief of Workmen.*

The diggers commence the ditch making an excavation 5 feet deep and 8 feet wide, which will be very little more than five cubic yards and a half per man.

*Task of the second Relief of Workmen, coming on duty at midnight.*

The diggers to double the width of the former excavation, making it 16 feet wide, with the same depth of 5 feet.

*Task of the third Relief of Workmen, coming on duty at daylight.*

To do as much as the enemy's fire will permit, without leaving off in consequence of a few casualties. The diggers will cut the front part of the ditch 18 inches deeper, with a step of 5 feet in rear, and they will also increase the width of the excavation, if possible.

*Task of the fourth Relief of Workmen, being the first Relief of the second night.*

The diggers should complete the deepening of the front



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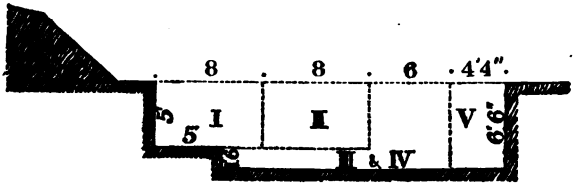
part of the ditch if necessary. Should that have been finished during the day, they will make the excavation 6 feet wider, at the new depth of 6 feet 6 inches.

*Task of the fifth Relief of Workmen, being the second Relief of the second night.*

To finish the parapet, at which period the ditch will have attained the full width of nearly 26 feet and a half in the unreveted profile.

The annexed figure represents the above tasks of the several reliefs of workmen, which are all distinctly marked,




excepting those of the third and fourth reliefs of workmen, which are left undefined, in consequence of the former of these two being employed by day, and therefore liable to be impeded by the enemy's fire.

The portion of work, allotted to each of the diggers of the fifth relief, is rather less than 4 cubic yards of excavation, which may be executed by good workmen with ease in a couple of hours. This is scarcely a sufficient task in easy soil, and it is possible that even less than the above may fall to the share of the men of this relief, which depends upon the progress made by the third relief during the day.

It may therefore be proper, instead of allowing the men of the fifth relief to leave off, on completing the parapet, to make them begin some other useful work ; for the operations of a siege should never be trifled with, by assigning inadequate tasks to any of the working parties.

*Secondly.—Of the Tasks proper for the several Reliefs of Workmen, employed about the Epaulments.*

These should be precisely the same, as in the construction of the epaulments of an elevated gun battery, in easy soil : and should therefore under all circumstances be finished by four reliefs of workmen. See in section III, those parts of articles 16, 17, 18 and 19, which apply to the epaulments ; the principle followed in which is, that the diggers of the two first reliefs, shall be required to execute about 6 cubic yards of excavation, and that the two last reliefs shall finish the work.

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**9. OF THE TASK PROPER FOR EACH RELIEF OF WORKMEN, IN THE EXECUTION OF A REVETED ELEVATED MORTAR BATTERY IN EASY SOIL.**

*First.—In the execution of the Parapet.*

In this profile as there is rather less labour, than in the former, I would recommend by all means to endeavour to finish the battery by four reliefs of workmen.

*Task of the men of the first Relief.*

To commence the ditch by making an excavation 5 feet deep, and 9 feet wide, which although greater than the task laid down in the foregoing article, is by no means unreasonable, being only at the rate of 6 cubic yards and a quarter per man.

*Task of the men of the second Relief.*

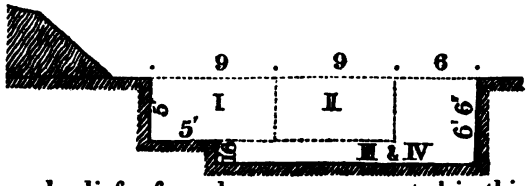
To double the width of the excavation, making it 18 feet wide in all.

*Task of the third Relief of Workmen, being the Relief of the first day.*

*Task of the fourth Relief of Workmen, being the Relief of the second night.*

The former to do as much as the enemy's fire will permit, cutting the fore part of the ditch 18 inches deeper. The latter to finish the parapet, if possible, at which period the extreme width of the ditch will be about 24 feet.

If the fourth relief should be likely to fail in this object, which the engineers on duty will be able to judge of, towards the close of the day, and before those men come on duty, a fifth relief of workmen must be demanded, who will have so very little to do, that a new task must be prepared for them, as soon as the battery shall be finished.




The annexed figure represents the tasks of the several reliefs of workmen, as suggested in this article, that of the third relief, who work by day, being left undefined as usual.

It appears to me very possible, to finish even the unreveted profile described in the former article, by four reliefs of good workmen, for it only requires about half a cubic yard more of excavation per man from the diggers of each relief, than is necessary in the reveted profile of our present article.

*Secondly.—In the execution of the Epaulments.*

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The tasks of the four reliefs of workmen employed may be precisely the same, as those proper for the unreveted profile. See the concluding paragraph of the preceding article.

### 10. OF THE TASK PROPER FOR EACH RELIEF OF WORKMEN, IN THE EXECUTION OF AN ELEVATED MORTAR BATTERY, IN DIFFICULT SOIL.

*First.—In the execution of the Parapet.*

Twenty three cubic yards being nearly the quantity of earth for the parapet of the unreveted profile, that each of the four diggers in a one-mortar portion of the battery is to furnish; this might be divided amongst six reliefs of workmen, which will be at the rate of 3 cubic yards and 5-6ths per man to the diggers of each relief: and a greater task could not with propriety be imposed upon a common military working party, in very difficult soil. But as the third and sixth reliefs of men come on duty during the day-time, and are consequently exposed to the enemy's fire, one cannot be sure, that those men will be able to add much to the progress of the work, excepting that the diggers may pick, and make a pile of loose earth under the berm. It is therefore not prudent to calculate upon completing the parapet of an unreveted elevated mortar battery, with fewer than seven or eight reliefs of men. This being premised, I shall proceed to describe the tasks that may with propriety be given to each.

*Task of the First Relief of Workmen.*

The four diggers of the first row, immediately in front of the exterior berm line, should form an excavation 5 feet deep and 5 feet wide: whilst the 3 diggers of the second row, placed at the parallel distance of 12 feet in front of the former, as directed in Section III, Article 7, should form an excavation of the same depth but only about 3 feet 9 inches wide, piling the earth upon the tongue between the two excavations.

*Task of the Second Relief of Workmen.*

To cut away half the tongue, so as to reduce it from the width of 7 feet to 3 feet 6 inches at top, and to clear away all the loose stuff by throwing it upon the parapet or berm. In this task the two rows of men should work together, in any way most convenient.

*Task of the Third Relief of Workmen, being the Relief of the first Day: and*

*Task of the Fourth Relief of Workmen, being the First Relief of the second Night.*

To cut away the remainder of the tongue, and to cut the

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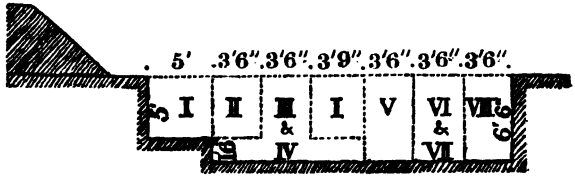
front part of the trench 18 inches deeper, leaving a step of 5 feet in width as usual, and at the same time to complete the parapet, as far as the quantity of earth thus obtained will permit.

It will depend upon the enemy's fire, whether these two reliefs will be able to finish this task or not. They can scarcely be expected to do more, unless entirely unmolested by the guns of the fortress.

*Tasks of the Fifth, Sixth, Seventh and Eighth Reliefs.*

As soon as the above deepening of the original trench shall take place, each successive relief of workmen excepting the sixth, may be required to cut the ditch 3 feet 6 inches wider in front, which at the depth of 6 feet 6 inches will be a sufficient task in difficult soil. Upon the sixth relief who are the relief of the second day, no regular task can be imposed, for the reason before stated.




The annexed figure represents the arrangement, in which part only of the parapet is shown. The two spaces I, I, represent the excavations of the two rows of diggers of the first relief, that which is immediately under the berm being the task of the men of the first row. The tasks of the second, fifth and eighth reliefs are marked in like manner by the corresponding Roman numerals II, V, and VIII. The tasks of the third and fourth reliefs, III & IV, and those of the sixth and seventh reliefs, VI & VII, are blended; as two of those reliefs work by day. It is very possible, that the parapet might be completed by seven reliefs of workmen only especially in the unreveted profile, if no unfavourable circumstance occurred. The tasks laid down for the diggers do not exceed three cubic yards and a quarter per man.

REMARK. It may almost appear unnecessary here to repeat a former observation, namely, that there may be many varieties of soil between the easiest and most difficult, that are to be found in nature. Hence the above tasks are not definitive for all circumstances. But to determine the tasks proper for the intermediate qualities of soil between these two, as well as the number of reliefs of workmen necessary

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for executing them, which ought of course to exceed four and fall short of eight, must be left to the judgment of the engineers actually employed in a siege. No precise rules can be laid down, for deciding upon such details before-hand.

## SECTION VIII.

### RULES FOR THE CONSTRUCTION OF SUNKEN MORTAR BATTERIES.

#### 1. GENERAL REMARKS ON SUNKEN MORTAR BATTERIES.

It was before explained, in treating of gun batteries, that there are circumstances, in which the sunken profile may be altogether improper for such batteries.

In respect to mortar batteries, the case is different. To these, the sunken profile is always quite as suitable as the elevated profile, for it must be evident, on considering the manner in which shells from a mortar are thrown, that it can make no possible difference in their effect against an enemy's works, whether the platform from whence they are fired, stands on the level of the natural ground, or in the trench of a sunken battery. It is true, that if the difference of level between two mortar batteries equidistant from a fortress, amounted to any thing considerable, such as 200 or 300 feet, the one might act much more efficaciously than the other: but any difference under 20 feet, and the depth of a sunken battery scarcely ever exceeds 3 or 4 feet, may be considered absolutely null. The only case, therefore, in which the sunken profile is objectionable for mortar batteries, is in marshy situations, where water is found a foot or two below the surface.

#### 2. OF THE PROFILE PROPER FOR THE PARAPET OF A SUNKEN MORTAR BATTERY IN EASY SOIL, AND IN DIFFICULT SOIL, RESPECTIVELY.

*First.—Of the Profile proper in easy soil.*

It was before stated, that the only advantage in sunken batteries, is the diminution of labour, that arises from using this profile. And consequently it must be evident, that as the dimensions of the trench are arbitrary in dry soil, the most advantageous depth that can be adopted will be that, which when extended to the width, that is most convenient for working the guns or mortars, shall just furnish a para-

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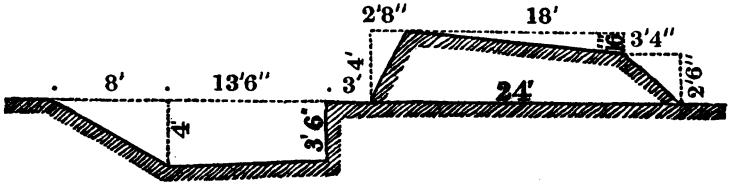
pet of the proper solidity. Under this consideration, it would be of no use to make the trench of a sunken gun battery deeper than three feet, because in that case, the parapet would be finished, before the trench was wide enough for the reception of the guns: and therefore it would be necessary to expend additional labour, in widening the trench after the parapet was completed, by throwing up more earth than was necessary, for the latter. Applying the same principle to a sunken mortar battery, it will appear, that the greater average depth of 3 feet 9 inches will be most suitable for the trench of such a battery. The reason is, that the parapet of a mortar battery being all solid, requires more earth than that of a gun battery of equal relief; at the same time, that the mortars, from the manner in which they are fired, require much less space for working them, than guns. Hence the trench of a sunken mortar battery may with propriety be made deeper, and narrower, than that of a sunken gun battery.

Moreover, as it is unnecessary to place mortar platforms close to the bottom of the parapet, a berm of 3 feet may be left, instead of 18 inches, which is proper for sunken gun batteries.




The foregoing figure represents the profile of an unreveted sunken mortar battery, constructed according to this rule in easy soil, the trench being 3 feet 6 inches deep in front and 4 feet deep in rear, like that of a parallel or an approacd. The parapet has the same thickness at top, and dip, similar slopes, and the same total relief, as in the unreveted elevated profile. In this figure, under the supposition that the excavated and elevated masses of earth are nearly equal, the width of the trench at bottom is 13 feet 6 inches, but if the parapet of this kind of battery were reveted, which saves a little earth, the trench would be about 13 feet in width only. The latter dimension is sufficient for the working of mortars.

The slope of the sole of the trench is regulated, not like that of a gun battery, in reference to the rise of the platforms, but in the contrary direction, to lead off rain water from the

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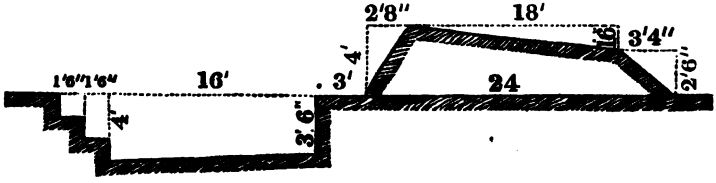
front of the excavation. Those parts, where the mortar platforms are to be laid, will be levelled afterwards.

*Secondly.—Of the Profile proper for the Parapet of a Sunken Mortar Battery in difficult soil.*

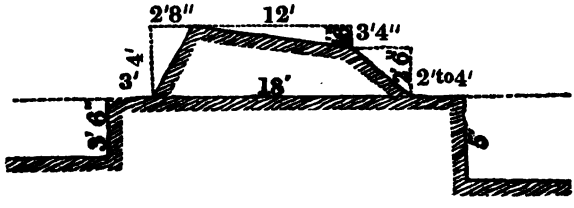
It has been shown, that in sunken gun batteries, two rows of diggers are useful at the commencement of the work in difficult soil, and the same arrangement is desirable in sunken mortar batteries: but the width of 13 or 14 feet for the sole of the trench, shown in the foregoing profile, does not give room enough for two rows of diggers to work to advantage. In difficult soil, therefore, the width of the trench of a mortar battery must be increased to 16 feet, in order to admit of the above beneficial arrangement: and in this case, the reverse of the trench must be finished with steps, as in the second figure annexed, because a gentle slope like that of the former profile, would furnish more earth than was necessary to complete the parapet.




The above profiles, for easy and for difficult soil respectively, are considered the most economical of labour, of any that can be adopted for the parapets of sunken mortar batteries.

*Thirdly.—Of the Profile proper for the Epaulment of a sunken Mortar Battery.*

This is the same for all soils, the earth being necessarily obtained from a ditch in front, with very little assistance from the trench in rear, which is chiefly required to furnish earth for the parapet. The epaulment is only 12 feet thick at top,




being made as usual 6 feet thinner than the parapet. In other respects it resembles the profile of that work, having

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an equal dip, and the same interior and exterior slopes, and similar berms; as shown in the annexed figure.

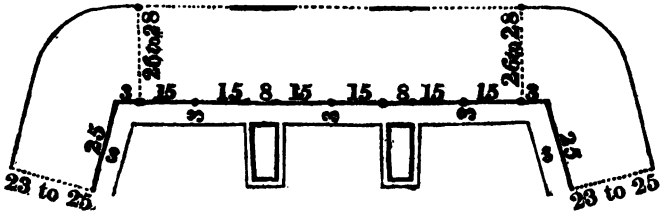
### 3. RULES FOR TRACING A SUNKEN MORTAR BATTERY ON THE GROUND.

In those parts where there are splinter proof traverses, the parapet cannot be formed from the trench in rear. It will, therefore, be necessary, in a sunken mortar battery, to have partial ditches in front of the parapet, opposite to the position proposed for each traverse: and the traverses themselves, must be traced and commenced, at the same time with the parapet. Hence the tracing of a sunken mortar battery is similar to that of a sunken gun battery, excepting in its having no embrasures. The additional length of parapet allowed for each common splinter proof traverse, may be about 8 feet, being 2 or 3 feet more than would suffice in an elevated mortar battery. The space of 3 feet must be added to each of the extreme mortars, on account of the berm of the adjacent epaulments.

Hence if we suppose, that a sunken mortar battery is to be constructed for 6 mortars, with 2 epaulments and 2 splinter proof traverses, the tracing will be represented in the following figure, in which the interior base line of the parapet will measure 112 feet, according to the following detail:

| | |
|---|---|
| 6 regular one-mortar portions, at 15 feet..... | 90 |
| 2 additional spaces for traverses, at 8 feet..... | 16 |
| 2 additional spaces, at the extremities of the parapet, at 3 feet..... | 6 |
| Total | 112 feet. |

The parallel distances for the partial ditches in front of the great portions of the parapet, and for the ditches of the epaulments, have been laid out in reference to the foregoing profiles, the first at from 26 to 28 feet, and the second at from 23 to 25 feet, respectively, which dimensions, include the base of the work, and the exterior berm of from 2 to 4 feet, but not the interior berm.

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Even when it is not intended to revet a sunken mortar battery, it is always most convenient to trace the interior base lines of the parapet and epaulments, as well as the exterior berm line of each partial ditch by fascines.

In a sand bag battery only, the tracing fascines are dispensed with, at the interior base line of the parapet, where the revetment is commenced at by a course of sand bags.

The interior berms of the parapet and epaulments must be traced at the distance of 3 feet.

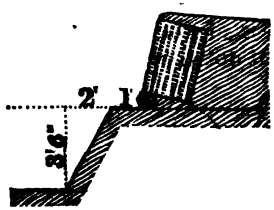
The traverses must next be traced. Those shown in the figure, are supposed to be 16 feet long, like those of a gun battery, and 5 feet wide at the base, as measured on the natural ground level, which dimension, together with a berm of 18 inches on each side, will make up the whole space of 8 feet allowed for each, in the tracing of the parapet. The traverse may be traced either by two parallel rows of gabions, or by a course of fascines, after which, their berms must be marked, on every side excepting the front.

It may be almost needless to observe, that where tracing fascines are not employed, tracing lines or white tape must be used to mark the several lines upon the ground, that are necessary for the commencement of the battery, as shown in the foregoing figure.

### 4. OF THE METHOD OF REVETING SUNKEN MORTAR BATTERIES, IF REVETED AT ALL.

There appears to me so very little use in reveting mortar batteries, with the exception of those commenced by the flying sap, the upper part of which is necessarily reveted in the course of that operation, that I should have preferred leaving the subject of this article altogether unnoticed, if it had not been laid down as a rule by all former authors, to follow this system, in all batteries without exception.

If however, it should be determined to revet a sunken mortar battery, one course of fascines, and one course of gabions over them, will suffice for reveting the upper part of the parapet, as shown in the annexed figure.




If fascines only be used, 4 or 5 courses will suffice.

If sand bags only be used, 7 or 8 courses will suffice.

Whichever of those materials be used, for the upper por-

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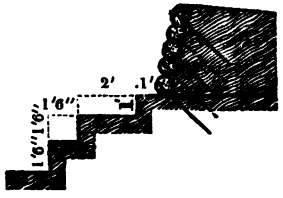
tion of the parapet, all below the ground line is left unreveted, but the front of the trench there is scarped away, by reducing the original berm from 3 feet to about 1 foot in width at top, as shown in the figure, excepting in the center of the space between two mortars, where a portion of banquette should be established, the top of which may be about 5 feet lower than the parapet, according to the rule before laid down, for the banquettes of batteries generally. The height thus fixed for the top of the banquette may either be obtained by a gentle slope, or it may be broken into two parts by a step of made earth, added in rear of the original berm line, and the superfluous part of the berm may then be cut away, as represented in the annexed figure, which is the section of the parapet of a sunken mortar battery, in the space between two mortars, having its upper part reveted with fascines,




Behind the center of each one-mortar portion, a step or level space must be formed, about one foot lower than the natural ground level, which is done by cutting away the rear part of the reverse slope of the trench. This step may be about 3 feet in length, and 2 feet in width, the former dimension being parallel to the interior base line. It is intended for the officers or non-commissioned officers of artillery, to stand upon occasionally, and look over the parapet, in laying their mortars, in case of great precision being required, as in that position, they will be able also to see the enemy's works, which they cannot do from the bottom of the trench.

### 5. OF THE QUANTITY OF LABOUR, AND MATERIALS, AND OF THE TIME NECESSARY FOR THE CONSTRUCTION OF THE PARAPET, EPAULMENTS, AND TRAVERSES, OF A SUNKEN MORTAR BATTERY.

*First.—Of the quantity of Labour necessary for the Parapet.*

The profile of the upper part of the parapet measures 68 superficial feet, so that in each running foot of parapet, there are very little more than $2\frac{1}{2}$ cubic yards. And in 15 feet being a regular one-mortar portion, there are $37\frac{1}{2}$ cubic yards.

Hence also, in each additional portion of parapet, oc-

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casioned by a splinter proof traverse, if supposed to measure 8 feet, there are about 20 cubic yards; and in each small portion of 3 feet extra at the extremities of the parapet, there are about 7½ cubic yards; but the latter are to be considered as a part of the shoulders, and the execution of each of those extra spaces will therefore be allotted to the men told off for the execution of the epaulment.

The above quantities of labour apply to the unreveted profile. Less is required for each portion of the reveted profile, but the difference is not sufficient to admit of fewer labourers being employed, or to occasion any material diminution of the time

*Secondly.—Of the quantity of Materials necessary, when Gabions are used.*

*For a regular one-mortar portion of the parapet:* 8 gabions, 1 fascine, and a quarter of a bundle of pickets.

*For the additional Parapet, occasioned by Splinter Proof Traverses.* For each one-traverse portion of 8 feet, 4 gabions, half a fascine, and one-eighth of a bundle of pickets.

*For the Tracing.* For that of the interior base line of the two epaulments, 3 fascines, and 3 quarters of a bundle of pickets. For the partial ditch in front of each traverse, 1 fascine, and one-eighth of a bundle of pickets.

*Thirdly.—Of the quantity of Materials necessary, when Fascines are used.*

*For a one-mortar portion:* 4 fascines, and 1 bundle of pickets.

*For the additional Parapet occasioned by Traverses.* For each one-traverse portion of 8 feet, 2 fascines and half a bundle of pickets.

*For the Tracing.* The same as in the preceding estimate.

*Fourthly.—Of the quantity of Materials necessary, when Sand Bags are used.*

*For a regular one-mortar portion,* measuring about 60 superficial feet, 96 sand bags.

*For the additional Parapet, occasioned by Traverses.* For each one-traverse portion of 8 feet, measuring about 32 superficial feet, 52 sand bags.

*For the Tracing.* The same number of fascines and pickets as in the foregoing estimates.

*Fifthly.—Of the quantity of Materials, necessary for each Splinter Proof Traverse.*

The traverses so nearly resemble those of a sunken gun battery, in their profile, that the same quantity of materials may be demanded for both, (see section IV, article 12.)

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In fact, the only difference is, that the traverses of the mortar battery, whilst they have the same total relief, are sunk 6 inches deeper beneath the surface of the original ground, than those of the gun battery. This is scarcely equal to the height of one course of fascines.

*Sixthly.—Of the Time necessary, for the completion of the Parapet.*

The quantity of earth required in the unreveted profile, being rather less than 38 cubic yards, for a regular one-mortar portion of the parapet, will be at the rate of somewhat less than 9½ cubic yards for each digger, employing four as usual, the greatest number who can possibly work in the space of 15 feet.

This may be executed by good workmen in about five hours of active exertion, in easy soil, and in about ten hours in the most difficult soil. But as it is not safe to calculate upon any extraordinary exertion from common military working parties, it will perhaps, be most prudent to demand two reliefs of workmen, even for the easiest, and three reliefs for difficult soil.

In the one-traverse portions of the parapet, supposed as above, to be 8 feet each in length, there are 20 cubic yards of excavation, which, if commenced by 3 diggers, and finished by 2, will be at the average rate of 8 cubic yards per man.

These portions of the parapet might be finished much sooner than the former, by employing more diggers for whom there is plenty of room, in the partial ditches in front: but it would evidently be useless to expedite this part of the work, when the other cannot by any means be made to keep pace with it.

*Seventhly.—Of the quantity of Labour and Time necessary for the Epaulments.*

The above estimates of labour and time apply exclusively to the parapet of the sunken mortar battery, which necessarily involves more labour than that of a sunken gun battery, in consequence of the former being entirely solid throughout, while the latter has embrasures, each of which does not measure much less than a common merlon. Hence if the same number of men that were before recommended in section IV, articles 13 and 14, for the epaulment of a sunken gun battery, were demanded for those of a sunken mortar battery, it is possible that the latter may be finished by one relief of workmen in easy soil,* and by two reliefs of workmen

* In a sunken two-mortar battery of this description, recently made by us for practice, in very easy soil, the traverse between the mortars was fi-

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in difficult soil, which is more than can well be accomplished, in respect to the parapet.

6. OF THE NUMBER OF WORKMEN NECESSARY FOR THE CONSTRUCTION OF A SUNKEN MORTAR BATTERY, IN EASY SOIL.

*First.—For each regular one-mortar Portion of the Parapet.*

For commencing a regular one-mortar portion, when unreveted, or when the upper part is reveted with gabions, 4 diggers, in the trench, 4 shovellers, and 2 rammers, making 10 labourers in all.

*Secondly.—For the additional Parapet occasioned by the splinter proof Traverses.*

For each one-traverse portion of 8 feet, employ 3 diggers in the partial ditch, with 2 shovellers and 1 rammer, making 6 labourers in all; and as the excavation increases, let one of the above diggers become a shoveller.

*Thirdly.—For the Epaulments.*

For each epaulment, including also the shoulder as usual, and the 3 feet of extra parapet adjoining thereto, occasioned by the interior berm of the epaulment, you may employ 9 diggers, 7 shovellers, and 4 rammers, making 20 labourers in all.

*Fourthly.—Number of Labourers, necessary for each splinter proof Traverse.*

For each traverse, not exceeding 5 feet in width at the base, employ 2 diggers, 2 shovellers, and 2 rammers, making 6 men in all.

*Fifthly.—Additional Workmen necessary, as Builders, when the upper part of the Parapet is to be reveted.*

In a sunken gabion mortar battery, none are required.

In a sunken fascine mortar battery, add 1 builder extra, to be occasionally assisted by one of the labourers of the former detail, per mortar and per traverse, if necessary.

In a sunken sand bag mortar battery, add 2 builders, and 3 builders' assistants per mortar, making 5 additional workmen in all: but for each traverse, add 2 builders and 1 assistant only, making 3 additional workmen in all; it being understood, that in this last case, the builders must also be assisted by two labourers of the former detail.

nished in less than two hours. One epaulment was finished in four hours. The second epaulment and the traverse-portion of the parapet were each finished in four hours and three quarters. The mortar-portions were finished, one in five hours, the other in five hours and ten minutes. Hence it is possible, that the whole might be finished by one relief of workmen; but have deemed it most prudent to demand two, excepting for the traverses.

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7. OF THE TASKS PROPER FOR EACH RELIEF OF WORKMEN, IN THE CONSTRUCTION OF A SUNKEN MORTAR BATTERY, IN EASY SOIL.

*Task of the First Relief of Workmen.*

*First.—In the regular One-Mortar Portions of the Parapet.*

The diggers will commence the trench in rear of the parapet, making it 10 feet wide, 3 feet 6 inches deep in front, and 3 feet 10 inches deep in rear, which involves a task of very little more than 5 cubic yards per man. The shovellers must be directed to throw their earth well to the front, so as to finish the outside of the parapet first.*

*Secondly.—In the One-Traverse Portions of the Parapet.*

The three diggers in the partial ditch in front, occupying a space of 13½ feet in length, will form an excavation 5 feet deep, and 5 feet 4 inches wide, throughout the whole of this extent being at the rate of about 4½ cubic yards per man. The shovellers must be directed to throw their earth well to their own front, they facing towards the rear of the battery, so as to finish the inside of their portion of parapet first.*

*Thirdly.—In respect to the Epaulments, including also the Shoulders, and the small Portions of Parapet adjacent.*

To raise the whole of these portions of the work to the average height of 2 feet 8 inches, which will more than half finish them.

*Fourthly.—In respect to the Traverses.*

One relief of workmen, told off according to the details laid down in the preceding article, ought to finish them with ease. They must be directed to form a complete passage, about 3 feet wide, round the rear of each traverse, by cutting into a part of the reverse slope of the one-mortar portions on each side; because the extreme end of the traverse extends further back than the sole of the trench of the battery. The remaining earth necessary for the upper part of the traverse, is obtained by working to the rear, within the space of 8 feet allotted for each one-traverse portion.

*Task of the Second Relief of Workmen.*

*First.—In the regular One-Mortar Portions of the Parapet.*

The diggers will cut the trench 3 feet 6 inches wider, which will increase it to the width of 13 feet 6 inches, giving

** The same rules apply to the shovellers, employed in the execution of sunken gun batteries, and ought therefore to have been introduced before. They hold good in all sunken batteries, whether the soil be easy or difficult.



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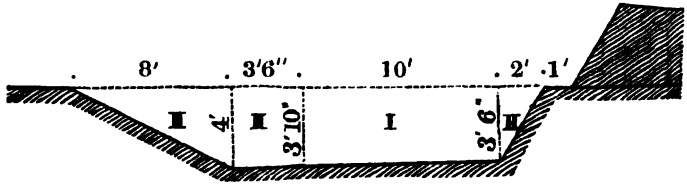
to it the extreme depth of 4 feet in rear.

They will then cut the reverse slope of the trench, giving to it a base of 8 feet, which is double its height, after which, they will scarp away the front of the trench, excepting in the central spaces between the mortars, where they will form small banquettes, as above described.

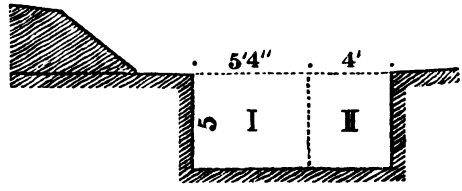
The annexed figure, which is the profile of an unreveted sunken mortar battery, represents the tasks of the diggers of the two reliefs, employed in the trench of a regular one-mortar portion, which are denoted as usual by the Roman numerals I and II. The task of the diggers of the second relief involves rather more than 4 cubic yards of excavation, per man, that is to say, in the unreveted profile, for




in the reveted profile the parapet will be finished, by means of the earth supplied from a trench of only 13 feet wide at bottom, being 6 inches narrower than that which is represented in the figure.

*Secondly.—In the One-Traverse Portions of the Parapet.*

Let the task be to finish these portions, at which period, the two diggers now supposed to be employed, will each have completed about 3¼ cubic yards per man; so that if they work in a space of 9 feet, they will have made that portion of the excavation 4 feet wider than they found it.




The annexed figure represents the tasks of the diggers of the 2 reliefs, employed in the partial ditches alluded to.

*Thirdly.—In respect to the Epaulments.*

To finish them, and to do any other additional work necessary near to, or connected with the battery, as the above would otherwise be too easy a task.

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8. OF THE NUMBER OF WORKMEN NECESSARY FOR THE CONSTRUCTION OF A SUNKEN MORTAR BATTERY, IN DIFFICULT SOIL.

*First.—Number of Labourers for each regular One-Mortar Portion of the Parapet.*

The arrangements are the same, as for commencing a sunken gun battery, in difficult soil. Two rows of diggers are employed in the trench in rear of the parapet, 4 in the first row, and 3 in the second, at the parallel distance of 12 feet apart. In the second and third reliefs, when the tongue is cut away, a part of these men must act as shovellers to the remainder.

Thus the detail at the commencement of the work is, 7 diggers, 3 shovellers, and 2 rammers, total 12 labourers.

The above are the whole number of workmen necessary for the unreveted profile, or when the upper part of the parapet is reveted with gabions.

*Secondly.—Number of Labourers for each One-Traverse Portion of the Parapet.*

Employ 3 diggers in line in the partial ditch in front, with 2 shovellers, and 1 rammer, making 6 labourers in all. And as the excavation increases, let one of the above diggers become a shoveller. The extreme workmen will throw their earth obliquely, towards the center of the space occupied.

*Thirdly.—Number of Labourers for each Epaulment.*

For each epaulment, including also the shoulder, and the 3 feet of extra parapet adjacent, employ 24 labourers, being twice as many as are proper for a regular one-mortar portion of the parapet. Of these, 12 may be told off as diggers, 8 as shovellers, and 4 as rammers.

*Fourthly.—For each Splinter Proof Traverse.*

For each traverse, not exceeding 5 feet in width at the base, employ as in the preceding article, 2 diggers, 2 shovellers, and 2 rammers, making 6 labourers in all: but as the soil is now supposed to be harder, let one of the shovellers occasionally act as a digger, when necessary.

*Fifthly.—Additional Workmen necessary as Builders.*

In a sunken gabion mortar battery, no extra men are required.

In a sunken fascine mortar battery, add 1 builder extra, to be occasionally assisted by one of the labourers of the former detail, per mortar, and per traverse, if necessary.

In a sunken sand bag mortar battery, add 2 builders, and 3 builders' assistants, per mortar, making 5 extra workmen



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in all; but for each traverse, add 2 builders, and 1 assistant only, making 3 extra workmen in all; it being understood, that in this last case, the builders must also be assisted by two labourers of the former detail.

9. OF THE TASKS PROPER FOR EACH RELIEF OF WORKMEN, IN THE CONSTRUCTION OF A SUNKEN MORTAR BATTERY, IN DIFFICULT SOIL.

*Task of the First Relief of Workmen.*

*First.—In respect to the regular One-Mortar Portions of the Parapet.*

The 4 diggers of the first row, will commence the trench in rear of the parapet, making it 3 feet 6 inches deep in front, 6 feet wide, and about 2 inches deeper in rear.

The 3 diggers of the second row, will commence their trench in rear of the former, at the parallel distance of 12 feet as usual, making it 3 feet 10½ inches deep in front, 4 feet wide, and 4 feet deep in rear, and piling their earth upon the tongue, between the two excavations, instead of throwing it over. When this is done, each digger will have cut nearly 3 cubic yards. Let them then be directed to work together, in clearing the front trench of those two entirely, and in throwing a part of the loose stuff from the tongue, upon the parapet. When the executive engineer shall find, that the two parallel trenches are completed to the full dimensions specified, and is of opinion, that about one-fourth part of the earth loosened by the second row of diggers, has been thrown upon the parapet, the men of this relief should be allowed to go.

*Secondly.—In respect to the One-Traverse Portions of the Parapet.*

The 3 diggers, commencing in line, in a space of 13½ feet, will form an excavation 5 feet deep, and 4 feet wide, throughout the whole of the above extent, being at the rate of 3⅓ cubic yards per man.

*Thirdly.—In respect to the Epaulments.*

Let the epaulment, shoulder, and the 3 feet of parapet adjoining, be raised to the average height of 1 foot 9 inches above the original ground, at which period, the work will be nearly half finished.

*Fourthly.—In respect to the Traverses.*

These should be raised about 3 feet above the original ground, which is only one foot less than the extreme height proposed.

*Task of the Second Relief of Workmen.*

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*First.—In respect to the regular One-Mortar Portions of the Parapet.*

The first and second rows of diggers will work together, in cutting away the tongue, which they will reduce from about 6 feet to 2 feet 6 inches in width. This being done, they will clear away all the loose earth from the trench, after which, their task will be considered finished.

*Secondly.—In respect to the One-Traverse Portions of the Parapet.*

The diggers in the partial ditch, who will now be reduced to two in number, occupying a space of 9 feet only, will make that portion of the excavation 4 feet wider, so that in finishing this task, they will have executed 3⅓ cubic yards per man.

*Thirdly.—In respect to the Epaulments.*

To raise them to the average height of 2 feet 8 inches, at which period, they will be more than two-thirds finished.

*Fourthly.—In respect to the Traverses.*

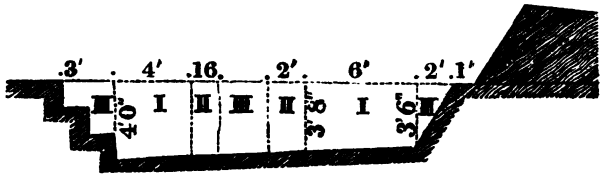
To finish them, together with the communications in rear of them, which will be a very easy task.

*Task of the Third Relief of Workmen, being the First Relief by Day.*

*First.—In respect to the regular One-Mortar Portions of the Parapet.*

The diggers in the trench, of whom a part will now act as shovellers, will cut away the tongue entirely, and they will then form steps in rear of the trench, each 1 foot 4 inches high, being one-third part of the extreme depth there, and 1 foot 6 inches wide. They will also scarp off the berm, in rear of the parapet, to the slope, before described, and form a portion of banquette between every two mortars. The parapet will then be finished.

The annexed figure represents the tasks of the several reliefs of diggers, employed in the trench, in each regular one-mortar portion of the parapet. The spaces I and I




are the parallel trenches of the two rows of diggers, of the first relief. The spaces II and II are the continuation of

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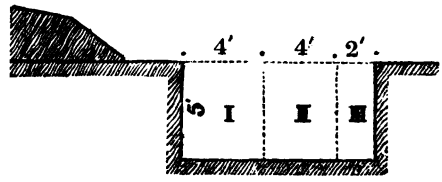
their respective excavations, during the second relief, whilst employed in cutting off part of the tongue, and clearing away rubbish. The spaces III, III, and III, show the finishing of the trench, by cutting away the remainder of the tongue in the center, and by forming the steps in rear, and the slope in front.

*Secondly.—In respect to the One-Traverse Portions of the Parapet.*

The two diggers in the partial ditch, must supply earth enough to finish the portion of parapet, that belongs to them, which they will accomplish, by cutting their trench to the extreme width of 10 feet, being only 2 feet wider than before.

The second figure annexed, represents the tasks of the diggers in the partial ditches, in the formation of each of the one-traverse portions of the parapet of a sunken mortar battery.




*Thirdly.—In respect to the Epaulments.*

To finish them, which will be a very easy task.

It is to be observed, that although the third relief of men work by day, neither the diggers in the trench nor in the ditches, will be seen by the enemy. The shovellers, on the top, and the rammers alone will be impeded by the enemy's fire, and indeed they may be prevented from working altogether; notwithstanding which one may safely calculate upon finishing the battery by this relief: for there are no embrasures to expose the workmen, as in a gun battery, and our recent experiments before alluded to have proved, that the ramming of a parapet is not so very essential, as has generally been supposed.

The subject of mortar batteries is now closed, with the exception of the platforms. I have not thought it worth while to treat of half-sunken mortar batteries, as they will evidently require much more labour than the sunken profile, without any compensating advantage.

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# SECTION IX.

## OF MORTAR PLATFORMS.

### 1. DESCRIPTION OF THE MORTAR PLATFORMS HITHERTO IN USE.

The kinds of mortar platforms, that have hitherto been generally used, are as follows:

*First.—Description of the present French Mortar Platform, which is laid on a horizontal Level.*

The present system in the French service, according to the most approved modern writers on the subject, is to form their mortar platforms entirely of timbers, 8 inches square, being rather more than 8¼ inches of English measure, three of which timbers are laid as sleepers, whilst the others are laid transversely over them, so as to cover the whole space allotted for the platform, with a substantial mass of woodwork. Four strong pickets are driven in front, and the same number in rear, to prevent these timbers from moving, but I cannot discover, that any pins, spikes, or screws, are ever used.

All their mortar platforms are made 6 feet wide; and either 7 feet, or 6 feet long, according to the nature of the mortar, the greater length being used for their 12 inch mortars, and for 10 inch mortars to be fired at long ranges, the lesser length for 10 inch mortars at short ranges, and for 8 inch mortars and stone mortars. This system is so different from ours, that it seemed proper to notice it. The last named dimensions are also in French measure, which is known to exceed English measure, of the like denomination, by about one-fifteenth.

*Secondly.—Description of the old French Mortar Platform.*

In the time of Vauban, a much greater number of sleepers, each 8 or 9 inches square, were used for mortar platforms, in the French service, which being placed at clear intervals, equal to their own width apart, were covered by 3 inch planks. Those platforms, which appear to have been 9 or 10 feet square, were laid like gun platforms with a rise of about 4 inches to the rear. It is positively directed, that

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the planks shall not be spiked or pinned down to the sleepers.*

*Thirdly.—Description and Weight of the old English Mortar Platform.*

The English mortar platform, used as an article of store, and sent out on all our expeditions during the late wars, was 14 feet long, and 8 feet wide, and was composed of 5 oak sleepers, each 14 feet long, and 9 inches square; and of 16 oak planks, each 8 feet long, about 10½ inches wide, and 3 inches thick. Hence at 50 lbs. to the cubic foot, the average weight of each sleeper must have been nearly 394 lbs., and the average weight of each plank about 87 lbs., so that the total weight of a platform of this description must have been 30 cwt. 2 lbs. The planks of these platforms were always spiked down to the sleepers.

The above makes an excellent platform for permanent purposes. Indeed it has always been used for the practice of heavy mortars at Woolwich, but with this trifling difference, that the 13 inch mortar platforms, in present use at that place are 2 feet wider, and have one more sleeper than the above; whilst the 10 inch mortar platforms now in use there are two feet shorter than the above. For field service, however, so very large and heavy a pattern appears unnecessary, and the weight of the sleepers in particular, would render the laying of such a platform under fire exceedingly difficult, if not almost impracticable, they being still more unwieldy than those of the old English gun platform, which were so strongly objected to, in the Peninsular war, as was before stated.

## 2. OF THE MORE MODERATE DIMENSIONS AND SCANTLING OF MORTAR PLATFORMS, THAT MAY BE ADOPTED FOR FIELD SERVICE.

The length and breadth absolutely necessary, for any mortar platform, must evidently depend upon the size of the mortar bed, and upon the recoil, that takes place, when the mortar is fired at long ranges, and consequently with large charges of gun powder.

The dimensions, and consequently the strength of scantling, proper for any mortar platform, must depend partly on the total weight of the mortar, and of its bed; and partly on the maximum charge of powder likely to be used.

* See Vauban's "Traité de l'Attaque des Places." Chap. XI. Ribbands (*Tringles*) are directed to be used all round, but in what manner they are to be secured, is not stated.

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The weight of iron land service mortars, mounted on iron beds of the last pattern, in the British service, are as follows: the 13 inch mortar and its bed about 70 cwt.: the 10 inch mortar and its bed 33 cwt.; and the 8 inch mortar and its bed, 16½ cwt.; in each of which weights respectively, rather more than one-half belongs to the mortar.

The 13 inch mortar bed measures nearly 5 feet 5½ inches, by 3 feet 10½ inches: the 10 inch mortar bed measures 4 feet 4 inches, by 3 feet 4½ inches: and the 8 inch mortar bed measures 3 feet 3 inches, by 2 feet 1 inch.

It has been ascertained, by the mortar practice of the Royal Artillery, that a 13 inch shell, weighing 198 lbs. may be thrown from its proper mortar, at an elevation of 45 degrees, to the distance of nearly 1970 yards, by a charge of 6 lbs. of gunpowder, which occasions a recoil of about 12 inches: but that an increased charge of 9 lbs. of powder, will produce a range of 2827 yards, and a recoil of 19 inches. Also, that a 10 inch shell, weighing 88 lbs. may be thrown from its proper mortar, laid at the same elevation, to the distance of about 2427 yards, by a charge of 4 lbs. of powder, which occasions a recoil of 17 inches; and that an 8 inch shell, weighing 44 lbs. may be thrown from its proper mortar, also laid at the same elevation, to a distance of 2193 yards, by a charge of 2 lbs. of powder, which occasions a recoil of 17 inches. In all cases, the above recoils took place, when the platforms were dry, for it was found that wetting them occasioned an increase of the recoil.*

In a regular siege, by which I imply, that the houses of the inhabitants shall not be bombarded, but that the fire of the besiegers' mortars shall be directed only against the fortifications, and the troops defending them, it can scarcely ever be necessary to fire at a greater range than about 1100 yards; for which distance, charges not much exceeding 3 lbs. for the 13 inch mortar, 1¾ lbs. for the 10 inch, and 1 lb. for the 8 inch mortar would suffice; and the recoils occasioned by such diminished charges would likewise be smaller in proportion. All these charges are moderate, and the recoils so much so, that they certainly could scarcely require any platform, as a matter of necessity to exceed the

* These details, are from the mortar practice, carried on at Sutton Heath, in 1811, with which I was favoured by Colonel Williamson, superintendant of the Royal Military Repository, at Woolwich. The weights of the present land service iron mortars and beds, and the lengths of the latter were taken from Spearman's British Gunner. The inferences relative to the proper charges for 1100 yards of each kind of mortar, were deduced from Adye's Pocket Gunner.

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length of its mortar bed by more than 2 feet, in common soil.

From the above statements, it must be evident, that any platform, large and strong enough for a 13 inch mortar, must be larger and stronger, than is necessary for a 10 inch, and still more for an 8 inch mortar; and that a 10 inch mortar platform, that is just sufficiently large and strong, must have in like manner, a certain excess of size and strength, above what is absolutely necessary for an 8 inch mortar.

The French and English mortar platforms, described in the preceding article, having both been used for the largest land mortars in common use in those respective services,* it follows, that the French size of platform, being the smallest of the two, and the English scantling, being the lightest of the two, may be adopted for field service, in preference to either; especially for such inland operations, in which water carriage is not available, and when consequently the saving of weight is an object of the greatest importance.

That the 8½ inch timbers, which cover the French mortar platform, are of superfluous strength, may be proved by the circumstance of all our English mortar platforms having been covered with 3 inch planks, and no want of solidity having ever been experienced.

Sleepers, 9 inches square, such as have been used in our service, appear however to me, to be of superfluous strength, it being considered, as was before noticed, in treating of those of gun platforms, that they are not like the joists of a bridge or floor, unsupported between their extreme bearings; but that they derive great aid from the solid ground, upon which they rest, and in which they are bedded. Under this consideration, sleepers of scantling, 6 inches square, and planks of 3 inches in thickness, seemed to be quite strong enough for mortar platforms; and on the principle of using more sleepers for the heavier, and fewer for the lighter kinds of mortars, it appeared practicable to make a mortar platform for general service, that should be equally suitable for the 13, the 10, and the 8 inch mortar.

Oak, is undoubtedly better for permanent platforms, as it is less liable to decay, by long exposure to damp, and wet: but for field service, fir, which is much lighter, may be considered preferable, as it is allowed to be equally strong.

* The calibre of the French 12 inch mortar, being equal to 12 inches and four-fifths of English measure, is very nearly equal to that of our 13 inch mortar.

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Under the above considerations, a new mortar platform, has been adopted in our practice at Chatham, which will form the subject of the two next articles.

### 3. DESCRIPTION OF THE NEW SIEGE MORTAR PLATFORM, RECENTLY ADOPTED AT THIS ESTABLISHMENT. NUMBER OF MEN NECESSARY FOR CARRYING IT, &c.

*First.—General Dimensions of the Platform.*

Seven feet 6 inches long, and 6 feet 6 inches wide, which is reduced by the use of ribbands, to the clear width of about 5 feet 10 inches only.

*Secondly.—The Sleepers.*

Seven feet 6 inches long, and 6 inches square. The arrises must be taken off, and the ends chamfered, and they must be tarred.

*Thirdly.—The Planks.*

Six feet 6 inches long, 3 inches thick, and 9 inches wide. They are notched for about 7 inches from both ends, but on one side only; and are bolted or hooped to prevent splitting, and have the center marked, exactly in the same manner as the gun platform planks, described in section VI. article 5, (see page 134.)

*Fourthly.—Of the Racksticks and Racklashings.*

Ten are used, similar to those of the gun platform, (see section VI, article 5, page 135.)

*Fifthly.—Detail, and Weight of the above Platform.*

| | CWT. | QRS. | LBS. |
|---|---|---|---|
| 6 sleepers, 7½ feet long, and 6 inches square, at 61 lbs..... | 3 | 1 | 2 |
| 10 planks, 6½ feet long, 9 inches in average width, and 3 inches thick, at 41 lbs..... | 3 | 2 | 18 |
| 3 ribbands, 7½ feet long, and 4 inches square, at 33 lbs..... | 0 | 2 | 8 |
| 10 racksticks, 15 inches long, with racklashings, 8 feet long, at 1½ lb*..... | 0 | 0 | 15 |
| Total cwt. | 7 | 2 | 15 |

*Sixthly.—Number of Men, necessary for carrying the above Platform.*

* In the gun platform, each rackstick and lashing were marked as weighing only 1 lb. The present weight applies to new ones of the full size. The first weight had been taken from old ones rather worn, and a little smaller than convenient.

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Allowing 1 man for each sleeper, plank, and ribband, 18 men may carry the whole platform. A non-commissioned officer may carry the racksticks.

REMARKS. To render the above mortar platform universal for each species of mortar, it is proposed to use the whole of the parts, as above described, for the 13 inch mortar, in which case, the clear intervals between the sleepers, will be only 8½ inches, which makes a very substantial mass of wood-work.

For the 10 inch mortar, it is proposed to use 5 sleepers only, which will increase the intervals to one foot in the clear, and 9 planks only may be used, instead of 10, if there be any scarcity of materials.

For the 8 inch mortar, it is proposed to use 4 sleepers only, which will increase the intervals to 18 inches in the clear, and 8 planks only may be used instead of 10, if there be any scarcity of materials.

### 4. ESTIMATE OF MEN, TOOLS, AND IMPLEMENTS, FOR LAYING A SIEGE MORTAR PLATFORM OF THE NEW PATTERN. EXECUTION OF THE WORK AND TIME.

*First.—Estimate of Men, Tools and Implements, for each Platform.*

| | |
|---|---|
| 4 men. | 1 rammer. |
| 4 pickaxes. | 1 six feet rod. |
| 4 shovels. | 1 maul. |
| 1 field level. | 8 strong pickets. |

1 broom, *for several platforms.**

The men must be strictly cautioned before-hand, not to cut or injure the sleepers by their tools.

*Secondly.—Execution of the Work.*

A rectangular space about 8 feet long and 7 feet wide must be marked by pickets for the position of the platform, the center of which space must agree with the center of the sole of the trench of the one-mortar portion of the battery, to which the platform is to belong. The longer side of this rectangle must be perpendicular to the parapet. The easiest mode of tracing it, is to lay down two of the platform sleepers parallel to each other, with two of the planks over them, so that all those four pieces shall be flush at the extreme ends, as shown in plan, forming a regular rectangle, in the manner represented in the annexed figure. This marks the precise space necessary for the finished platform. The

* The same implement would be useful in the laying of Gun Platforms.

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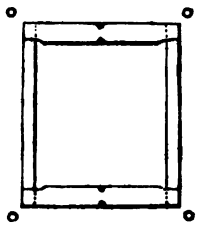
pickets must be driven a few inches farther out on each side, so as to embrace the larger space of about 8 by 7 feet, as before specified. The sleepers and planks are then removed, and the whole space included between the pickets must be entirely cleared of earth to the depth of about 6 inches, and the bottom levelled, by means of the field level applied in various directions, and rammed if soft. The two sleepers and the two planks are then again placed in their former position, within this excavated space, so as to form the same rectangle as before, the angles of which are corrected by the field level used as a square, if necessary. These sleepers, which will now be nearly in the proper position for the extreme sleepers of the proposed platform, must be correctly levelled, first longitudinally, and then transversely in the same manner before explained in section VI. article 6, in treating of gun platforms, but with this difference, that in the mortar platform, both of these levellings must be perfectly horizontal. A little earth must be added, under either of the sleepers by shaking it in, very fine with the hand, or taken away from under it by the shovel, if necessary, until the proper level is obtained.



Before these two sleepers are finally adjusted, the rack-lashings, 5 in number, must be introduced under each of them, with the sticks outwards, at equidistant intervals of 18 inches apart, the extreme lashings being placed 9 inches from the ends of the sleepers. This being done, the lashings are turned over to the outside of the extreme sleepers, and the intermediate sleepers, which in the 13 inch mortar platform are four, in the 10 inch platform three, and in the 8 inch mortar platform two in number, must be introduced into the space between, and laid perfectly parallel and equidistant, which may generally be done with sufficient accuracy, by a good eye. The tops of all the sleepers must next be brought into the same plane, by using a couple of platform planks, as straight edges, which must be applied transversely, both in front and rear, adding to, or taking away a little earth from under any particular sleeper, if required.

When all the sleepers are correctly laid, part of the earth before excavated, is placed in the intervals between, and rammed, until the whole are completely bedded in earth. When six sleepers are used, which leaves very

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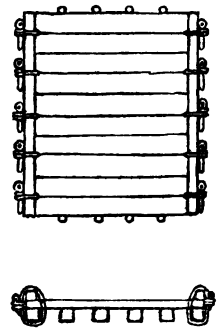
narrow intervals, it is best to tread the earth down with the feet, previously to ramming it, which must be done with great care, to avoid injuring the sleepers.

The planks are then laid transversely over the sleepers, and the ribbands across the extreme ends of the planks, after which the sides are racked down, by racklashings fixed at intervals of 18 inches apart, as before directed, that is between the ends of every two planks, with the extreme racklashings between the two extreme planks on each side.



Four pickets are driven immediately in front, and four in rear of the platform, to prevent the planks against which they press, from moving.



The above particulars, are explained in the two foregoing figures, the first of which is the plan, and the second the section of a mortar platform of the above description, having six sleepers, and consequently being intended for a 13 inch mortar.

*Time.* Expert men, who have practised this operation repeatedly, can lay a mortar platform of the above description, in the stiffest soil, in rather less than three-quarters of an hour, and can completely dismantle it in three minutes.

5. THAT THE SMALL BRASS MORTARS FOR LAND SERVICE DO NOT REQUIRE REGULAR PLATFORMS.

*First.—Description of the small Brass Mortars for Land Service.*

The small brass mortars for land service, are $5\frac{1}{2}$ inch mortars, or Royal mortars, and $4\frac{2}{5}$ inch mortars, or Coehorn mortars. They are both mounted on wooden beds. The weight of the former, including its bed, is nearly $2\frac{1}{2}$ cwt. and the weight of the latter, also including its bed, is not quite $1\frac{3}{4}$ cwt. Of the above weights, rather more than one-half of each belongs to the mortar. The length of the Royal mortar bed, is 2 feet 7 inches, that of the Coehorn mortar bed, is 2 feet 5 inches, and the width of each, is 15 inches. Their respective shells weigh about 15 and 8 lbs.

* When six. or even five sleepers are used, it is best to excavate the whole space that is to be covered by the platform, as described in this article. When only four sleepers are used, you may, if you think proper, cut grooves for them, according to the rule followed in respect to the sleepers of a gun platform.

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Mortars of the above description, may very easily be moved from one part of the trenches to another, their parts being so extremely light; and they may be fired from any part of the trenches, without requiring a regular battery. They are generally used for short ranges, the greatest charge that can be required, not exceeding about 8 ounces of gunpowder for the Royal, and 6 ounces for the Coehorn mortar. Hence, considering also their lightness, they do not require regular platforms, for a piece of plank, about 4 feet long, will answer the purpose. If the ground be very soft, two parallel pieces of plank may be used as sleepers, to support a third plank, upon which the mortar bed is to rest, the whole being combined in the form of the capital letter H, laid upon its side, the center line of which, should agree with the proposed line of fire of the mortar. This will give more stability, than the use of a single plank, but if these light mortars be fired from the natural grass, or if the excavated ground upon which they are placed, should be dry and hard, or if it can be made hard by ramming, all such expedients may be dispensed with.

## SECTION X.

### OF THE LEAN-TO, OR TRIANGULAR FIELD POWDER MAGAZINE, GENERALLY USED DURING THE LATE WARS.

#### 1. PRELIMINARY OBSERVATIONS ON THIS KIND OF FIELD POWDER MAGAZINE.

The field powder magazines, used in the sieges, carried on by the British army, during the late wars, were generally formed by laying stout timbers, which were usually termed splinter proof timbers,* at an angle of 45 degrees, sloping towards the fortress, against an earthen parapet, reveted interiorly, so as to inclose a space, of which the section is nearly a right angled triangle.

* The term, 'bombproof', might be used with more propriety, if one knew the precise circumstances, under which timbers of a certain scantling are bombproof. But as this point is doubtful, I use the term sanctioned by custom, although the timbers employed were always much stronger, than is implied by the word splinter proof.

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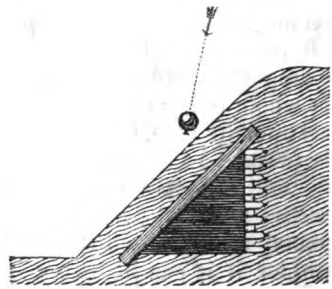
This form, called a lean-to, in reference to a technical term in carpentry, is by no means convenient for stowage; but it was adopted, as being well calculated to resist the effect of the enemy's shells, which by descending rather obliquely, and sometimes probably at a slope nearly approximating to that of the leaning timbers of the field powder magazine, are less likely to break through it, than if those timbers were laid in any other manner.

The annexed figure, for example, represents a shell falling upon the slope of a magazine of this description, in the manner supposed, which evidently could do little or no injury to the magazine.



There are however other points, in which the magazine if struck by a shell would be more vulnerable, but this circumstance is not a serious objection to the above construction, as will be noticed hereafter.

Having stated, that the same principle was followed in both, it will be understood, that the details of the construction, about to be described in the remainder of this section, apply to the system adopted at this establishment only, without reference to the field powder magazines made on service, in the late wars, no correct descriptions of any of which are in my possession, and of which in all probability very few were exactly alike.

## 2. GENERAL DESCRIPTION OF THE TRIANGULAR FIELD POWDER MAGAZINE.

*First.—Body of the Magazine*

The body of the magazine is 15 feet long, 6 feet 6 inches wide at bottom, and 6 feet 6 inches high in the clear, so that its internal profile is an isosceles right angled triangle.

*Secondly.—The Passage or Entrance.*

The above length is increased to 18 feet, to allow room for a passage leading perpendicularly from one end of the body of the magazine towards the rear, which passage is 4 feet 6 inches high, and 2 feet 6 inches wide in the clear, between the rectangular frames, which support the roof of this part of the magazine.

*Thirdly.—Of the Communications to the Magazine.*

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The magazine is surrounded on all sides, excepting in front, by a trench of communication, which thus forms three sides of a rectangle, parallel to the rear and ends of the body of the magazine. The passage or entrance into the magazine before-mentioned, opens from the rear or center line of the above angular trench. The ends of the trench afford two communications, from the magazine towards the parapet of the battery, or other work, behind which it may be situated.

3. DESCRIPTION OF THE FRAMEWORK FOR THE BODY OF THE MAGAZINE, AND PASSAGE, AND OF THE WOOD-WORK AND REVETING MATERIALS FOR THE MAGAZINE GENERALLY.

*First.—Framework for the Body of the Magazine.*

The body of the magazine has its sloping side covered with timbers, as before-mentioned, and its perpendicular side reveted by planks below, and by fascines above, the level of the natural ground. These reveting materials are retained by upright stanchions, placed at intervals of rather less than 4 feet apart, which are supported by struts or oblique pieces butting against them, so that each pair, consisting of a stanchion and its strut, forms a kind of frame. The magazine timbers aline with the struts, and are placed in the intervals between them.

In order to arrange the above magazine frames more regularly, two parallel sleepers or groundsills, each 15 feet 6 inches long, and 3 inches deep, are sunk longitudinally, along the two sides of the bottom of the body of the magazine, to which sleepers, the lower ends of the frames are fitted transversely. The sleeper, which receives the feet of the stanchions, has mortises for that purpose, 4 inches long by 1½ inch wide, in plan, and 1½ inch deep, and each stanchion is formed with a tenon at bottom of corresponding dimensions. The other sleeper, which receives the lower end of the struts, has notches on its upper surface, each half an inch in depth, and 4 inches in width, extending transversely across its whole breadth, and this sleeper is laid at an angle of 45 degrees. The former sleeper is 4½ inches, and the latter 7 inches wide.

The stanchions are joggled 6 inches from the top, to the depth of about 1½ inch, for the head of the strut to butt against, besides which they are mortised to the same depth, making 3 inches in all, to receive a tenon formed at the head of each strut, and parallel to the oblique side of the joint. The top of the stanchion is strengthened by a couple of hoops



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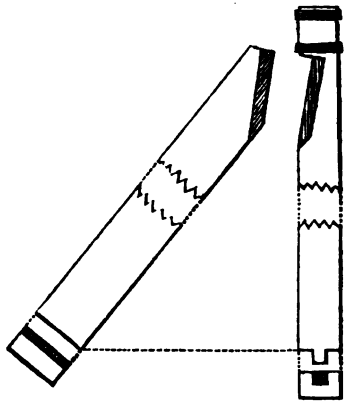
of hoop-iron, which may be secured by rivets or nails.

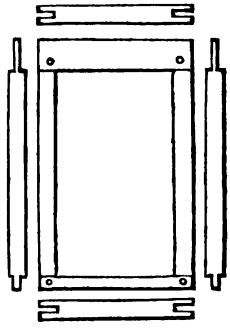
The annexed figure represents all the joints of this frame-work, according to a transverse section of the body of the magazine. The middle length of the stanchion and that of the strut are broken off, to prevent the figure from taking up too much room. The two sleepers, one notched, the other mortised, are shown in section, below the parts that are to fit into them.



*Secondly.—The Entrance or Passage Frames described.*

These are in 4 pieces, viz.: 1 ground sill 3 inches deep by 5 inches wide, 2 stanchions 5 inches square, and 1 capsill 5 inches wide by 8 inches in depth. As they require more solidity than common mine frames, it was deemed expedient to frame them together permanently in such a manner, as to leave the clear space of 4 feet 6 inches high by 2 feet 6 inches wide, as before-mentioned.

The pieces are put together like a door frame in common joinery. The capsill and groundsill are each mortised, through their whole depth, to receive the tenons at top and bottom of the stanchions. These mortises are open at the extreme ends. The annexed figures represent this arrangement, in which the rectangular figure shews the frame in elevation, hook-drawn and pinned at the joints, according to custom.



Above and below are represented the capsill and the ground sill both in plan, and on each side, are represented the stanchions in elevation, all these detached pieces, which serve to explain the nature of the joints, being turned half round, or at right angles to their respective positions in the elevation of the frame.

*Thirdly.—Splinter Proof Timbers.*

At this establishment, we propose* to use pieces of 9 inches in depth, and of the average width of 6 inches, that is

* The word 'proposed,' is used, because our present splinter proof timbers measure rather less than 9 inches in depth.

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such as will occupy that space one with another, without being jammed, which implies nearly a quarter of an inch less in nett width. Any increase of depth will of course increase the strength of splinter proof timbers in a still greater proportion. On service, it might often be necessary to cut down trees, for the purpose of forming these timbers, and in this case unnecessary labour should be avoided, by choosing any scantling of sufficient strength that may appear most convenient, without squaring all the sides. If timbers of 6 inches or upwards in average width cannot be procured, a greater number of planks set on edge, will answer the purpose.

*Fourthly.—Sheeting Planks and Fascines.*

One and a half inch planks may be used for lining the lower part of the upright side, and of the ends, of the body of the magazine, as well as the passage. These planks may either be cut into short lengths of about 4½ feet like the sheeting planks of the mines, or they may be of greater lengths, and consequently in fewer pieces, which will perhaps be more convenient, but in this last case, they must be cut to several lengths to suit the form of the magazine; and they must be secured at the ends by bolts or hoops, to pre vent them from splitting.

The fascines, used for the upper part above the natural level of the ground, ought to be cut, to suit the extent of the work proposed to be thus reveted: but at this establishment we abstain from cutting them, to avoid waste.

4. DETAIL AND WEIGHT OF THE MATERIALS FOR A TRIANGULAR FIELD POWDER MAGAZINE. REMARKS. NUMBER OF MEN NECESSARY FOR CARRYING THEM.

*Frame-work for the body of the Magazine.*

| | CWT. | QRS. | LBS. |
|---|---|---|---|
| 5 stanchions, each 7 feet 10 inches long, and 4 by 4½ inches scantling, at 35 lbs. | 1 | 2 | 7 |
| 1 ground sill for the stanchions, 15 feet 6 inches long, and 3 by 4½ inches scantling, at 50 lbs..... | 0 | 1 | 22 |
| 5 struts, each 9 feet 10 inches long, and 4 by 7 inches scantling at, 61 lbs.. ..... | 2 | 2 | 25 |
| 1 ground sill for the struts, 15 feet 6 inches long, and 3 by 7 inches scantling, at 76 lbs..... | 0 | 2 | 20 |
| *For the Passage.* | | | |
| 4 frames, 5 feet 6 inches high, and 3 feet 4 inches wide from out to out, at 96 lbs... | 3 | 1 | 20 |
| Carried over, cwt. | 8 | 3 | 10 |



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| | | | |
|---|---|---|---|
| Brought over, cwt. | 8 | 3 | 10 |
| *To line the sunken part of the Magazine.* | | | |
| 45 sheeting planks, about 4 feet 6 inches long, 1 foot wide, and 1½ inch thick, at 20 lbs. | 8 | 0 | 4 |
| *To cover the sloping side and extreme end of the Body and the Passage.* | | | |
| 26 splinter proof timbers, of the average width of 6 inches, 9 inches deep, and 10 feet long, at 130 lbs. | 30 | 0 | 20 |
| 9 long splinter proof timbers, of the same scantling, but 13 feet 6 inches long, at 175½ lbs. | 14 | 0 | 7 |
| Weight of woodwork, cwt. | 61 | 0 | 13 |
| *Add to line the upper part of the upright side of the Body, and to lay over the Splinter proof Timbers.* | | | |
| 4 fascines, at 120 lbs. | 4 | 1 | 4 |
| 200 superficial feet of tarpaulin, probably | 0 | 2 | 0 |
| Total weight of materials, cwt, | 65 | 3 | 17 |

*Secondly.—Remarks.*

The weights above-stated apply to well-seasoned fir. If sheeting planks of less width than 1 foot, or if timbers of less width than the average of 6 inches be used, their respective numbers demanded, of each sort, must be increased in proportion. If timbers of greater width be used, the number must be diminished. An increase in the depth of the timbers used, or the use of green wood, or of the harder woods instead of fir, will of course produce a corresponding increase of weight.

*Thirdly.—Number of Men required for carrying the above Materials.*

Allowing 1 man to every two sheeting planks, and also 1 man to each strut, stanchion and sill, 2 men to each passage frame, and to each short splinter proof, and 3 men to each long splinter proof timber, the whole of the woodwork may be carried by 122 men. For the fascines and tarpaulin, add 10 men more, and all the materials of the magazine, as above detailed, may be carried by 132 men.

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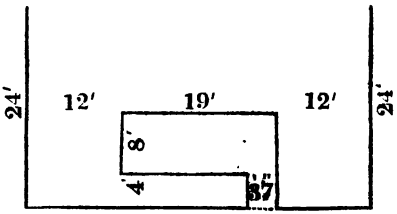
## 5. RULES FOR TRACING A TRIANGULAR FIELD POWDER MAGAZINE ON THE GROUND.

The body of the magazine, which must be about 35 feet in rear of the parapet, if placed behind a battery, is traced 19 feet long by 8 feet wide in the clear, which first dimension is laid out parallel to the face of the battery. Parallel to the rear and ends of the rectangle thus traced, three lines are traced outwards, as it were inclosing it, in the form of three sides of a rectangle, at the distance of 4 feet in rear, and of 12 feet from each end.

The two returns or perpendiculars of this second tracing are each made 24 feet long. The passage is traced by producing one end of the body of the magazine towards the rear, which produced line determines one side of the passage. The other is traced parallel to the former, at the distance of 3 feet 7 inches. The annexed figure represents this very simple tracing.




## 6. OF THE NUMBER OF WORKMEN, TOOLS AND IMPLEMENTS, NECESSARY FOR CONSTRUCTING THE TRIANGULAR FIELD POWDER MAGAZINE, AND OF THE ARRANGEMENTS PROPER IN THE EXECUTION OF THE WORK.

*First.—Number of Workmen.*

Fifteen is the greatest number that can be employed at the commencement of the work, but they may be increased to 20 after the first relief in easy soil, but not till the second relief in difficult soil.

*Secondly.—Tools and Implements.*

| | |
|---|---|
| 15 pickaxes. | Tracing line. |
| 15 shovels. | 2 six feet rods. |
| 4 rammers. | Half a bundle of pickets |
| 1 field level. | (12 in number). |

*Secondly.—Execution of the Work.*

The whole of the 15 men must at first be employed as diggers, of whom six must cut the great rectangle for the body of the magazine, and one must cut the smaller rectangle for the passage, after which he may extend his excavation

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still further to the rear, by working beyond the rear line of the tracing, so as to excavate a part of the proposed trench of communication there. The remaining eight men being equally divided between those two trenches, which are laid out parallel to the ends of the body of the magazine, must commence digging from the outside of the lines traced for that purpose, and facing inwards.

Knowing in what manner the earth is to be disposed of afterwards, the officer, or non-commissioned officer superintending, must cause all the diggers to throw their earth in such a manner, that it shall not have to be moved, unnecessarily again. Three diggers in the body of the magazine must therefore throw their earth to the front. The three others, and the digger in the passage, will deposit their earth to the sides and rear, those two who deposit it towards the rear, taking care to pile it at a little distance, instead of throwing it far from them, because the whole of the earth excavated by these men in particular will necessarily have to be moved afterwards. The four diggers in each of the returns or extreme trenches, will throw their earth inwards, those who are placed opposite to the body of the magazine taking care not to throw it so far, as to fall into the rectangular excavation preparing for that purpose.

The body of the magazine and passage will be cut four feet deep, which must be done with all expedition, in order that no time may be lost in placing the frame-work, which is the next operation.

The two trenches, commenced at the same time, may also be cut four feet deep in rear, but towards the extreme end or front of each, the depth must be diminished, as it will be necessary to finish them eventually in the form of ramps, leading to the battery.

In preparing to place the frame-work of the body of the magazine, the two sleepers for receiving the stanchions and struts are laid parallel to each other, at the clear distance of 6 feet 6 inches apart, in grooves properly prepared, the former being laid horizontally, and the latter at an angle of 45 degrees, as was before-mentioned. These occupy about 15 feet of the length of the excavation of the body of the magazine, the rest of which belongs to the passage.

When the two sleepers are laid, the stanchions and struts must be connected with each other, and fitted to their respective sleepers by pairs, as soon as possible; and the stanchions must be secured by wedges or otherwise, to keep them steady for the present. The four passage frames

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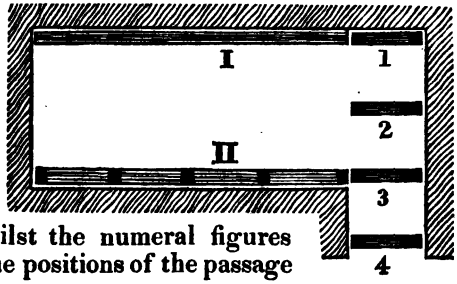
are then placed, one in the direction of the stanchion sleeper produced: the other parallel to it at the distance of about 11 feet to the rear, that is a little in front of the alinement marked for the front of the rear trench: the other two are then set up at equidistant intervals between these two.

This arrangement is represented in the annexed figure, in which the Roman numerals I and II represent the two sleepers, shewing the mortises or notches for the stanchions and struts of the framework of the body of the magazine, whilst the numeral figures 1, 2, 3, and 4, show the positions of the passage frames.




The sheeting planks are then introduced between the stanchions of the body of the magazine and the side of the vertical excavation adjacent, until the whole of the sunken part of the magazine is lined with woodwork on that side: after which, the upper part may be reveted by about three courses of fascines; the sheeting and fascines together being so arranged, as just to cover a space of about 6½ feet in height from the sole of the excavation upwards. The splinter proof timbers are then laid, in the intervals between the triangular frames of the body of the magazine, with the foot of each resting on the strut sleeper, and the top of each lying against the uppermost course of fascines. At the same time the extreme end and the two sides of the passage are lined with sheeting planks, excepting of course that part of one side, which must be left open to communicate with the body of the magazine. The whole passage including the extreme end of the body, is then covered by splinter proof timbers laid horizontally over all the capsills, which being done, the whole of the timbers must be covered by tarpaulins.

In placing the sheeting, fascines, and timbers, the whole of the men will be required to hand those materials, which will previously have been laid near to the spot. As soon as the above shall be disposed of, the labourers' work must again proceed until the magazine is finished. About three and not exceeding four men may be employed as rammers; the remainder as diggers and shovellers. In consequence of its being impossible, to dispose of all the first excavated portions of earth properly, until the magazine shall be

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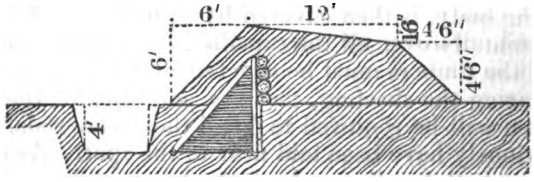
covered in, let as many men as possible be employed as shovellers, until the loose earth, especially that in rear of the magazine shall be thrown upon the parapet, until it attains the dimensions that will be specified in the following article.

### 7. DIMENSIONS PROPER FOR THE FINISHED PARAPET OF THE TRIANGULAR FIELD POWDER MAGAZINE.

The dimensions of the parapet of a field powder magazine are of course to a certain degree arbitrary; but being sheltered by another parapet in front, it is not necessary to make it so thick as the parapet of a regular battery, which otherwise would be proper. We have therefore given to the parapets of our triangular field powder magazines, a thickness of 12 feet at top, an interior height of 6 feet, and an exterior height of 4 feet 6 inches. The base of each of the end slopes was laid out at an angle of 45 degrees, the interior slope being of course regulated by the splinter proof timbers, which cover the body of the magazine. We sometimes made the base of the exterior slope equal to its height, as in the following figure. Sometimes we increased it to about 6 feet, which exceeds the height in the usual proportion of one-third. A small berm of from 1 to 2 feet, according to the nature of the soil, may be left between the base of the parapet, and the sides of the trench of communication, and the latter may be sloped a little if necessary.

In the sieges in Spain, a covering of sand bags filled with earth was usually laid over the sloping timbers.* In the practice of this establishment, we lay on about 2 feet of earth with a view of saving the sand bags, and we also dispense with tarpaulins, although the latter should undoubtedly be used on service.

The method of finishing the sloping or triangular field powder magazine will be sufficiently understood from the




* The sloping timbers might be covered by about 13 fascines laid transversely over them, which by their elasticity would increase the resistance to shells. This expedient was recommended in a little book entitled Memoranda on Batteries, lithographed by me three years ago: but it has since occurred, that generally speaking it is best to dispense with all materials not absolutely necessary.

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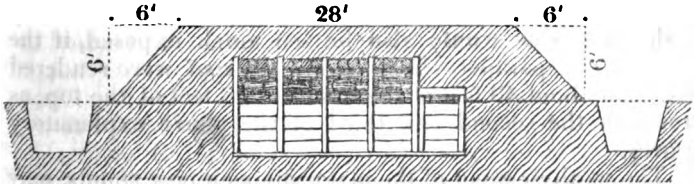
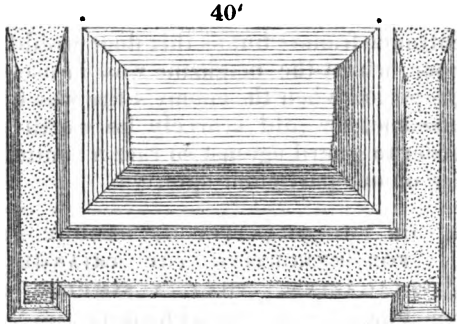
three annexed figures. The first which is placed at the bottom of the foregoing page, is a transverse section of the body of the powder magazine, showing the internal excavation and frame-work, and the trench in rear, and also fully illustrating the profile of the parapet.

The second figure annexed, is a longitudinal section of the body of the magazine taken at right angles to the former, close to the stanchions or upright side of the magazine. It also shews the section of the passage, as covered by horizontal timbers laid over the capsill of the frame. It is likewise a longitudinal section of the parapet, on each side of which, those two trenches, which are parallel to the ends of the magazine, are shown.




The third figure annexed, which is on a smaller scale than the others, is a plan of the top or roof of the finished magazine, representing the trench of communication surrounding it, at the two angles of which recesses are made for sess-pools, into which the rain water falling in all parts of the trench is conducted, and from which in the case of heavy rains, it must be occasionally baled out.




At the time, that the parapet shall be finished to the above dimensions, the trenches of communication, of which the extreme depth no where exceeds 4 feet, will necessarily have been cut wide enough, to admit of two men passing each other throughout their whole extent. Care must of course be taken, as the labour of forming the parapet draws to-

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wards a conclusion, that those trenches shall be brought to a regular form, and that the two returns shall be sloped off at the extreme ends, in the form of ramps ascending towards the battery, or other work, in rear of which the magazine may be situated.

The parapet that has been described can scarcely be considered too strong, for although the magazine may be deemed perfectly bomb proof against shells falling upon its sloping roof, there would be little resistance against a shell falling immediately in front of the top of the sloping timbers, and just beyond the vertex of the triangle, on the perpendicular side of it, if the parapet were not raised to the height of at least 6 feet in that part, as shown in the transverse section, which allows a mass of three feet and a half of earth above the said vertex. The extreme ends of the body of the magazine would also be too much exposed, if the length of the parapet which covers the roof were rendered less than about 40 feet at the base and 28 feet at the top, as shown in the second and third of the above explanatory figures.

The weakest point of the magazine, as it now stands, may be considered its risk from the effects of a shell falling into the trench in rear, and bursting exactly opposite to the entrance. This might in some degree be prevented by a door to the magazine, hung to the second frame on entering, and falling back in the recess between that and the first or outer entrance frame: but as this door would require to be always open, whilst the magazine was in use, and consequently at the period when the enemy's fire was likely to be most troublesome, it would scarcely be worth while to make one, in order to guard against so rare a contingency, as a shell falling on one particular spot.

8. OF THE QUANTITY OF LABOUR AND TIME, NECESSARY FOR EXECUTING THE TRIANGULAR FIELD POWDER MAGAZINE. THAT A SIMPLER CONSTRUCTION MAY PERHAPS BE PREFERABLE.

*First.—Of the quantity of Labour.*

By a rough measurement of the dimensions of the parapet of the magazine, as described in the foregoing article, it appears that it cannot require much less than 120 cubic yards of earth, and it was before-stated, that this quantity cannot well be diminished, without weakening the magazine too much. Of the above quantity about 24 cubic yards are obtained from the body and entrance of the magazine.

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*Secondly.—Of the Time necessary,*

The whole of the excavation necessary cannot be commenced simultaneously, nor can the parapet be put into shape, until the woodwork in the body of the magazine and passage shall be completely fixed, which may just be accomplished by the first relief of workmen in easy soil; but would form the task of the second relief of workmen in difficult soil. Hence it becomes impossible to expedite the work by increasing the number of workmen, until after the above period. Then some little time might be saved by employing 20 men, being 5 more than can work to advantage at the commencement. In our practice at Chatham, we have hitherto never employed more than 15 at any period of the work, so that we have never finished any of those magazines in less than nine or ten hours in the easiest soil. The longest time ever required was fifteen hours and a half in difficult soil.

Hence it may be allowed, that one could scarcely hope to finish a magazine of this description upon service, by fewer than three reliefs of the common military working parties, in the easiest soil, or by fewer than five reliefs in difficult soil, even if an increased number of workmen be demanded for the two or three last reliefs.

The above magazines are good when finished, and quite as safe as can reasonably be required, for it must be recollected that nothing is absolutely safe in war.

In the whole of the British sieges during the Peninsular war, there is only one instance of a field powder magazine having been blown up; which was not precisely of the same description, as it was formed by timbers resting against the gorge revetment of a captured outwork, with its ends not so well protected as in the above construction.

Notwithstanding these reasons in its favour, we have however long been dissatisfied with the quantity of labour and time, required in the execution of this kind of magazine; and therefore we have recently adopted a simpler form, which may not perhaps be considered better than the above in some respects, but which I am myself inclined to prefer to it, under the consideration that there is a certain degree of labour, which it is not worth while to exceed, for the sake of greater security. This new construction will form the subject of the next section.

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## 9. OF POWDER BARRELS, AND POWDER BOXES FOR LAND SERVICE. NUMBER OF EACH, THAT THE TRIANGULAR FIELD POWDER MAGAZINE WILL CONTAIN.

*First.—Dimensions of the Common Powder Barrel.*

In the British service, gun powder for land service is kept in barrels, not entirely full, of the average length of 1 foot 9 inches, and of the average extreme width of 1 foot 5½ inches, measured exteriorly, which dimensions determine the space required for stowage, it being observed however, that when placed in tiers, every course excepting the undermost will occupy a less average height by about two inches than the extreme diameter of one barrel, by laying the upper barrels in the hollows between those of the course beneath. Each barrel contains 90 lbs. of powder, and as the barrel itself usually weighs about 28 lbs., the average weight of a filled barrel is 118 lbs. These barrels are opened, by setting them upright and taking out the upper end, after first knocking off a couple of the extreme hoops at that end; and when they are to be used again, this ought to be done by a cooper, or at least by a very careful man.

*Secondly.—Number of Powder Barrels that the Triangular Field Powder Magazine will contain.*

If one of the triangular field powder magazines, which forms the subject of this section, were to be filled with the common powder barrels above described, I would recommend them to be laid in three tiers or courses. The first or lowest course to consist of three rows of 8 barrels each, placed longitudinally on the floor of the powder magazine, and as close to the sloping side as possible, and wedged on the other side to prevent them from rolling. The second course to consist of two rows of 8 barrels each, and the third course to consist of one row only, also of 8 barrels. This makes 48 barrels in all, containing 4320 lbs. or 540 rounds for a 24 pounder breaching battery, placed as I before observed, longitudinally, or so that the extreme length of the barrels shall agree with that of the body of the magazine, of which they will fill 14 feet in length, leaving at the same time a sufficiently convenient passage, along the whole of the perpendicular side of the magazine, from one end to the other.

*Thirdly.—Dimensions of the New Powder Box for Land Service.*

It may be remarked, that there are strong objections to the system of filling the field powder magazines of the gun batteries in a siege, with common powder barrels. For it is evident, that in this case it would be necessary to open the

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barrels, and make up the powder into cartridges, in the magazine itself, which is not a good arrangement; for accidents are much more likely to occur from handling loose powder, at or near the batteries, when engaged with the guns of the fortress, than at the park or depôt of artillery, at some distance in rear of the trenches, which is not exposed to the enemy's fire at all.

Oblong wooden boxes, filled with cartridges for the heavy guns, were therefore generally used in all our siege batteries, during the late wars; but recently, instead of a variety of sizes for the service of different calibers, it has been proposed to adopt a general powder box of a new pattern for land service, to be fitted to the limbers of field pieces, as well as to limber waggons, and which it is also proposed to use in future for the service of sieges. This box measures 19 inches in length, 11¼ inches in width, and 18 inches in depth from out to out, including in the last dimension the thickness of a couple of small rope handles near the ends. It opens at one end, and is always to be filled with powder in cartridges, but the extreme weight of the powder is limited to 80 lbs. Hence one of these boxes will hold ten rounds for a 24 pounder, employed in breaching, in cartridges of 8 lbs. each, being the full service charge for that caliber. The box itself weighs rather more than 22½ lbs., so that including also the flannel, the total weight of each box when full will be about 104 lbs.

*Fourthly.—Number of Powder Boxes, that the Triangular Field Powder Magazine will contain.*

The most advantageous method of stowing them, so as to leave a passage along the upright side of the body of the magazine, is to place two rows of boxes transversely, in the first row, laying them on their sides, to take up less height, and over these to place one row transversely in the second course, setting them upright, and one row longitudinally and also upright, in the third course. By this arrangement, there will be 20 boxes in the first course, 15 in the second, and 8 in the third, making 43 in all, so that the magazine will hold 3440 lbs. or 430 rounds for a 24 pounder breaching battery.

Of the boxes, thus stowed, 25 may be opened, and the cartridges taken out, without displacing any of the others. One row only of the lower tier cannot be got at, until all the other boxes shall be removed.

Remark. Cartridges have not hitherto been used for mortars, so that in all our late sieges, the powder has been sent to the mortar batteries, exclusively in barrels.

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# SECTION XI.

## OF THE RECTANGULAR OR FLAT ROOFED FIELD POWDER MAGAZINE.

### 1. GENERAL DESCRIPTION OF THIS KIND OF MAGAZINE. MATERIALS NECESSARY FOR CONSTRUCTING IT.

*First.—General Description.*

The chief objection to the triangular magazine being the very large parapet required, which is occasioned by the vertex of the triangle necessarily rising to a great height, in order to afford space for stowage in that inconvenient figure; it occurred, that by adopting the rectangular section, a much smaller excavation would afford equal room for stowage, and that much less height, and consequently a much smaller parapet would answer the purpose.

After having made some experimental magazines of this description, we therefore fixed upon the following dimensions.

The rectangle for the body of the magazine to be 12 feet 3 inches long by 6 feet 3 inches wide, and to have a passage leading from one end at right angles towards the rear, as in the former magazine: and also to be surrounded on three sides by a trench of communication, but of much less extent, and constantly involving less labour.

*Secondly.—Frame-work for the Body of the Magazine, not including the extreme end of it.*

This consists of four frames, each 4 feet 9 inches high by 4 feet 4 inches wide, from out to out. Each frame has 1 groundsill, 3 inches deep and 5 inches wide, 2 stanchions 5 inches square, and 1 capsill 7 inches deep and 5 inches wide, put together so as to make up the extreme dimensions before specified.

*Thirdly.—The Entrance or Passage Frames.*

These also are four in number, and measure 4 feet 9 inches high, and 3 feet wide from out to out, and have each 1 groundsill, and 2 stanchions, of the same scantling as those of the body frames just described, and 1 capsill 8 inches deep and 5 inches wide, which is therefore one inch deeper than the former.

Both the body frames and passage frames are framed and pinned together, precisely in the same manner as the passage

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frames of the triangular magazine, as described in article 3 of the preceding section, page 178.

*Fourthly.—Sheeting Planks.*

For this, 1½ inch planks may be used, of different lengths to suit the form of the magazine, and its passage, all the sides of which must be lined, by introducing the sheeting horizontally and on edge, between the backs of the stanchions of the frames, and the excavated earth. The long side of the body of the magazine, and the long side of the passage, are each to be lined by 12 feet sheeting. The short side of the body of the magazine is to be lined by 9 feet sheeting. The short end of the body of the magazine, and the short side of the passage, are to be lined by 6 feet sheeting.

Three of the 6 feet sheeting planks must be cleated on one side, as temporary gauges for determining the positions of the capsills of the body frames, whilst being placed, and for preventing them from collapsing, until the time shall arrive for introducing some cleated splinter proof timbers, which cannot conveniently be used at first.

The cleats fixed to these planks at the extreme distance of 5 feet 2 inches apart, or of 5 inches from each end, are more properly speaking ledges, being 3 inches wide, 1 inch thick, and of such length as to extend the whole width of the plank. They are chamfered on the inside and at the two ends, and are secured to the planks by 5 three inch nails, 2 at each end, and one in the center of the ledge, which are driven through both and clenched. The annexed figure represents one of the cleated planks in longitudinal section, with the two ledges on its lower side, in transverse section. The capsills of opposite frames, which are kept in their places by these ledges, are dotted.

*Fifthly.—Splinter Proof Timbers.*

These may be of the same scantling as in the former magazine, namely 6 inches in average width, and not less than 9 inches in depth, and likewise of two different lengths, 10 feet for the body of the magazine, and 13 feet 6 inches for the extreme end and passage. Four of the short splinter proofs must be cleated on their lower sides, in the manner represented in the following figure, in order to prevent the

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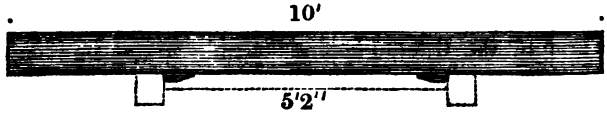
body frames from collapsing at top, in consequence of the pressure of earth in loose soil. The cleats may be 6 inches long, 2½ inches wide, 1½ inch thick at the end which receives the pressure, and about three-quarters of an inch thick at the other end. They should each be secured by three nails, two of which driven through the thick end should be about 4 inches long, whilst the third driven through the thin end may only be 3 inches long. They are fixed at the extreme distance of 5 feet 2 inches apart, which determines the distance in the clear between the capsills of the opposite body frames. The positions of the latter are shown by the two small dotted rectangles, as in the former figure.




2. DETAIL AND WEIGHT OF MATERIALS FOR A RECTANGULAR FIELD POWDER MAGAZINE.—REMARKS.—NUMBER OF MEN NECESSARY FOR CARRYING THEM.

| | CWT. | QRS. | LBS. |
|---|---|---|---|
| *For the Body and Passage.* | | | |
| 4 body frames, 4 feet 9 inches high, and 4 feet 4 inches wide, from out to out, at 97 lbs. | 3 | 1 | 24 |
| 4 passage frames, 4 feet 9 inches high, and 3 feet wide, from out to out, at 84 lbs. | 3 | 0 | 0 |
| *To Line the Magazine.* | | | |
| Sheeting planks, 1½ inch thick and 1 foot wide. | | | |
| 8 of 12 feet, at 58 lbs. | 4 | 0 | 16 |
| 4 of 9 feet, at 44 lbs. | 1 | 2 | 8 |
| 8 of 6 feet, at 29 lbs. | 2 | 0 | 8 |
| *To cover the Body and Passage.* | | | |
| Splinter proof timbers, 6 inches in average width, and 9 inches deep. | | | |
| 19 of 10 feet, at 130 lbs. | 22 | 0 | 6 |
| 7 of 13 feet 6 inches, at 175½ lbs. | 10 | 3 | 24 |
| Total woodwork, cwt. | 47 | 1 | 2 |

*Number of Men required for carrying the above materials.*

Ninety-one men will be required, allowing 3 men to each long splinter proof timber, 2 men to each short splinter proof timber, and to each frame, 1 man to each of the long planks, and 1 man to two of the short planks.

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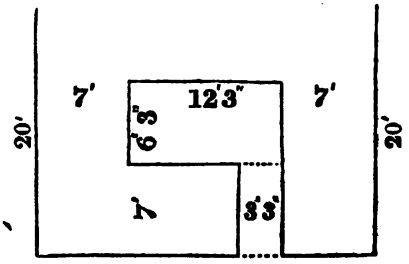
**Remarks.** The outside parts of the body frames, as well as of the splinter proof timbers should be moderately chamfered by taking off the arrises, and the ends of the sheeting planks hooped or bolted, as was before directed, in respect to similar pieces of wood-work, to prevent the former from being injured, and the latter from splitting.

### 3. RULES FOR TRACING THE RECTANGULAR FIELD POWDER MAGAZINE. NUMBER OF WORKMEN, TOOLS, AND IMPLEMENTS NECESSARY.

*First.—Of the Tracing.*

The body of the magazine, which must be at least 30 feet in rear of the parapet, when placed behind a battery, is traced in the form of a rectangle, 12 feet 3 inches long by 6 feet 3 inches wide, which first dimension is laid out parallel to the base of the parapet, and in a gun battery opposite to a merlon. Lines are then traced in the form of three sides of a rectangle inclosing the former, at the distance of 7 feet from the rear and ends of it, the returns or extreme sides of these three being made 20 feet in length. Lastly, the passage is traced, which is made 3 feet 3 inches wide, with one of its sides in the direction of one end of the body of the magazine, produced towards the rear. The annexed figure represents this tracing, which is precisely similar to that of the former magazine, excepting in its detailed dimensions, which are generally smaller.




*Secondly.—Number of Workmen, Tools, and Implements.*

| | |
|---|---|
| 10 men. | 1 field level. |
| 10 pickaxes. | Tracing line. |
| 10 shovels. | 2 six feet rods. |
| 2 rammers. | Half a bundle of pickets |
| 2 pushpicks. | (12 in number). |

### 4. OF THE EXECUTION OF THE RECTANGULAR FIELD POWDER MAGAZINE, WITH REMARKS.

This may be divided into three periods, each of which requires a different arrangement of the workmen.



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*First.—From the commencement of the Work, until the excavation is ready for receiving the Frames.*

During this period the whole of the men will be employed as diggers, 3 in the body of the magazine, 1 in the passage, 3 in the trench in rear of the body, 2 in that return which is farthest from the passage, and 1 in that which is nearest to it. The men in the body of the magazine will throw their earth to the front, the digger in the passage will throw it to one side. The diggers in the trenches of communication will pile their earth on the tongue of 7 feet, intervening between their own respective excavations, and the body of the magazine, taking care to leave a berm of about 2 feet in width, between the mass of earth thus thrown up, and the excavation for the body of the magazine. When they can no longer pile their earth on the tongue, without encroaching upon this space, let them pile it on the other side, or on the reverse of their own trenches.

If the magazine be placed behind an elevated battery, the two returns or extreme branches of the trench of communication must be formed into ramps 3 feet deep in rear, and diminishing by a gradual slope towards the front: but if it should be placed behind a sunken battery, these returns should be cut to the depth of about 3 feet, even in front, in order that they may connect with the reverse of the trench of the battery, nearly on a level. Thus the returns alluded to may either be finished as ramps or as trenches, according to circumstances. The trench in rear must first be cut 3 feet deep throughout, after which, a portion of 10 feet in length, opposite to the entrance of the magazine, must be cut 1 foot deeper, or a little more, and small ramps formed at each end of this deepened portion. The whole of the trenches of communication must be 3 feet in width at bottom, giving them if you think proper, a moderate increase towards the top. It is probable that the whole of these trenches will be formed, before the body of the magazine and passage are cut to their proper depth, for which 4 feet has been judged most convenient. At this time loose earth, in sufficient quantity to form the whole parapet, will have been obtained.

*Secondly.—The fixing of the Wood-work for the Body and Entrance of the Magazine.*

As soon as the body and passage shall be excavated to the full depth, the respective frames belonging to each will be placed, by sinking their groundsills in grooves cut for the purpose, about 3 inches deeper than the general level of the previous excavation. Two body frames and one passage

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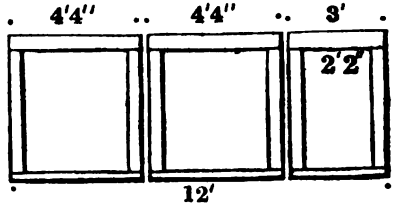
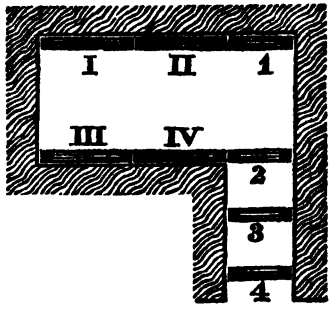
frame will then be set up along each side of the body of the magazine, in the same continued alinement, and at intervals of about 2 inches apart, so as to occupy the extreme length of 12 feet, as represented in elevation in the annexed figure.




In arranging the two parallel lines of frames in this manner, the opposite groundsills must be placed at the distance of 6 feet, from out to out. The cleated planks must then be laid transversely over the capsills of each opposite pair of frames, with the cleats downwards, to regulate the distance of these frames at top, and to prevent them from collapsing. The two remaining passage frames will then be set up in the passage, in rear of the former, and parallel to them, at clear intervals of 2 feet apart. The whole of the frames will thus be placed, in the manner shown in plan, in the annexed figure, in which the four body frames are marked by the Roman numerals I, II, III, and IV, whilst the four passage frames are marked by the numeral figures 1, 2, 3, and 4.




The sheeting planks, of three different lengths as before explained, to suit the several sides of the excavation, must then be introduced, in the intervals between the stanchions of the frames; and the earth which is to be supported; in which operation, as these planks are used in the same manner as the side sheeting of the galleries of mines, the miner's tool called the pushpick, shaped like a small pointed gardener's spud, is used for clearing away superfluous earth if necessary.

The four cleated splinter proof timbers must next be laid transversely across the capsills of the two opposite pairs of body frames, and near to their ends, introducing the cleats between the two lines of capsills in the proper position, as before explained; after which, the cleated planks, that were temporarily used in the same manner, will be removed, and placed as sheeting planks for the upper part of the short sides of the excavation.



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This being done, the earth must be made good, about the frames and sheeting on all sides, until it is raised to the same horizontal level as the tops of the frames, that is 6 inches higher than the natural ground level; after which the remainder of the splinter proof timbers must be laid transversely over the capsills of all the frames, the short ones over the body, the long ones over the passage; in such a manner, that the ends of the whole shall aline in front, with those of the three cleated splinter proofs before placed. One or two more should be laid parallel to the others, and in continuation of them on each side, upon the earth immediately beyond the extreme ends of the excavation. During the operation that has been described, the whole of the men will be required to bring up and place the wood-work.

*Thirdly.—The finishing of the Parapet or Roof of the Magazine.*

As soon as all the splinter proofs are laid, 2 of the men will take up rammers, whilst the remaining 8 will throw the loose earth previously excavated, over the timbers, so as to form the parapet, or roof, allowing a small berm, and a slope having its base equal to its height, towards the three sides of the trench of communication. In front, the same or a greater slope may be allowed, as you think proper, the latter arrangement not being imperative, as in the exterior slopes of batteries, which are exposed to a direct fire. The parapet now under consideration, should be raised on all sides to the height of 4 feet above the original ground level, which must not be exceeded, excepting in the center, where it must be raised nearly 6 inches higher, and from thence slopes will be made to each side of the rectangular top, formed as above directed; which if it had greater height, would resemble a quadrangular hip roof.

The three figures annexed, are sections to illustrate the nature of a rectangular field powder magazine, supposed to be formed, according to the above rules, in rear of an elevated battery, and consequently having ramping returns. The roof or parapet thereby formed will measure in transverse section about 19 feet at the base, and 9 feet 6 inches thick at the top, as shown in the first and second of these figures. The first is a section taken through the body of the magazine, and the trench in rear, at a part where the latter is 3 feet deep. The thickness of the parapet would of course be somewhat increased, if the returns led to a sunken battery, in which case, they would become trenches instead of ramps, and would therefore furnish more earth for the front of the parapet.

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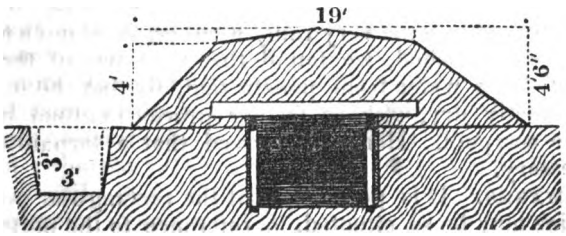
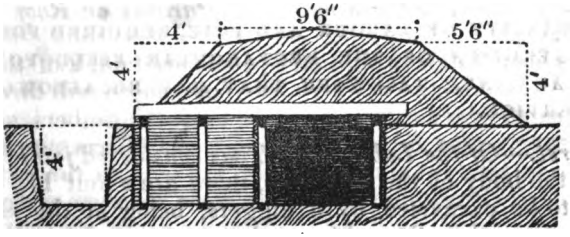
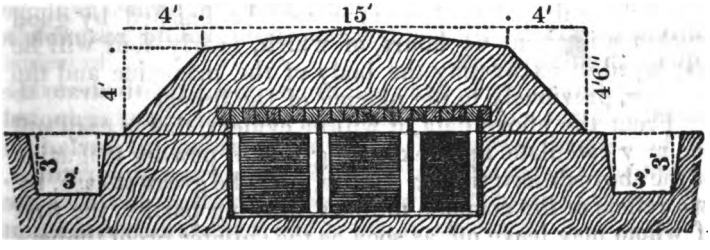



The second figure annexed, is a transverse section of the magazine, parallel to the former, but taken through the passage, opposite to which, the trench in rear is 4 feet deep.




The third figure annexed, is a longitudinal section of the magazine, taken also through the two returns of the trench of communication. In this description the parapet measures about 23 feet in length at the base, and 16 feet at the top.




*Fourthly.—Precautions for keeping the Magazine dry.* For this purpose, a sesspool must be formed, somewhere in rear of the deepest part of the trench of communication, that is opposite or nearly opposite to the entrance of the magazine, and a part of the trench must be lowered a little if necessary, in order that the rain falling at the entrance may be led off towards the sesspool.

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Having recently made a magazine of this description, and left it exposed to some very rainy weather, for about a month after it was finished, we found that the form of the roof prevented the water from penetrating, so that the interior was perfectly dry, without farther precaution than baling out the sesspool. Hence we agreed that a tarpaulin was unnecessary.

REMARKS. It is possible, that the rectangular powder magazine may be so situated, in reference to the parapet of the battery to which it is attached, that two returns from the trench in rear would be superfluous. In this case, the width of that trench as well as of the single return leading from it toward the battery, must be increased, in order to afford sufficient earth for the parapet of the magazine.

5. QUANTITY OF LABOUR AND TIME, REQUIRED FOR THE EXECUTION OF THE RECTANGULAR FIELD POWDER MAGAZINE. TASKWORK THAT MAY BE ALLOWED ON SERVICE.

*First.—Of the Labour and Time considered jointly.*

In the body of the magazine, there are about $11\frac{1}{2}$ cubic yards to be excavated by 3 diggers, being at the rate of rather more than $3\frac{3}{4}$ cubic yards per man, which may be executed by good workmen in less than 2 hours, in easy soil. After this the placing of the whole of the wood-work requires rather less than an hour, and to complete the roof or parapet rather less than an hour and a half more: so that the magazine may be finished in about four hours, by good workmen in easy soil.

In difficult soil, the magazine may be finished by good workmen in about $6\frac{1}{2}$ hours, of which, nearly four will be employed in excavating the body of the magazine and the passage, previously to the placing of the frames.

From the above data, it will be evident, that in easy soil one may calculate upon executing a field powder magazine of the above description, in a siege, with the greatest ease, by two reliefs of the common military working parties, the first of whom may leave off, as soon as the splinter proof timbers shall be placed. Indeed it would not be unreasonable to require one relief of workmen to finish it, in very easy soil.

Even in difficult soil, one may calculate upon completing the magazine by two or at least by three reliefs of the common military working parties, in a siege. I do not think it can require more than three reliefs, because although the third relief will commence by day, these magazines are so low, that the workmen will not be much exposed, the more

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especially as they are usually commenced in rear of a finished parapet.

### 6. OF THE QUANTITY OF POWDER, THAT MAY BE CONTAINED IN THE RECTANGULAR MAGAZINE.

*First.—Number of Common Powder Barrels, each containing 90 lbs.*

In stowing away powder barrels in this magazine, they may be laid in three tiers or courses; placing two transverse rows of 6 each in the first course, two transverse rows of 5 each in the second, and the same number in the third or upper course. This makes 32 barrels in all, containing 2880 lbs. or 360 rounds for a 24 pounder breaching gun, and at the same time leaving a passage from one end of the magazine to the other, independent of the entrance passage. By filling a part of the first of the above passages, 12 more barrels may be got in, amounting in all to 44 barrels, or 3960 lbs., or 495 rounds for a 24 pounder breaching gun.

*Secondly.—Number of Powder Boxes, each containing 80 lbs.*

These may be arranged in three tiers or courses. The two first courses to consist of two transverse rows of 10 boxes each, placed upright, with a passage in the center. The third course might also consist of the same number of boxes, if the magazine were two or three inches higher, but as there is scarcely room for another upright course without jamming, and as it does not appear expedient to make the interior height of the magazine greater than 4 feet 6 inches; let the third course of boxes consist of two transverse rows of 6 boxes each, laid flat on their sides, by which means the height of the whole pile will be a fraction less than 4 feet. The number of boxes that may be stowed away in this manner, is 52 in all, which will contain 520 cartridges of 8 lbs. each, for a 24 pounder breaching gun, or 4160 lbs. of powder.

By placing the proper end of each box towards the passage, all the cartridges might be taken out, without opening a single box, but in all probability it would be deemed preferable, to send the ammunition boxes themselves to the battery, one or two at a time, which when emptied would be put aside in some convenient part of the trenches near, in readiness to be sent back to the park of artillery for a new supply. By filling a part of the longitudinal passage also, this magazine might hold 20 boxes more, making 72 in all, which would contain 720 rounds for a 24 pounder breaching gun, or 5760 lbs. of powder.

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These 20 boxes may be placed in two longitudinal courses of two rows of 4 boxes each, placed upright, with a third course over these, of 4 boxes laid on their sides.

### 7. COMPARISON OF THE TRIANGULAR FIELD POWDER MAGAZINE BEFORE DESCRIBED, AND OF THE RECTANGULAR ONE.

*First.—In regard to Stowage.*

The triangular field powder magazine holds more common powder barrels by one half than the rectangular field powder magazine; but not quite so many of the new pattern powder boxes.

*Secondly.—In regard to Labour and Time.*

The triangular field powder magazine requires 15 workmen, and cannot be finished in less than 9 hours, in the easiest soil, whereas the rectangular field powder magazine may be finished by 10 men in 4 hours, in the same description of soil.

Upon the whole, there can be no doubt that the rectangular field powder magazine, recently adopted by us, is a very great improvement upon the former. It is the most convenient for the stowage of powder boxes, which are always used for direct gun batteries in a siege, and which may probably hereafter be also applied at least partially, to the service of mortars and howitzers. It may be finished in about one-half of the time. It involves only one-third of the quantity of labour; and it appears to me to be quite safe enough. Entertaining therefore so strong an impression of the superior advantages of the rectangular magazine, I would not have described the triangular one at all, if it had not been so generally used in the late wars, and also for a great number of years at this establishment.

### 8. THAT GABIONS AND FASCINES MAY BE USED FOR THE INTERIOR REVETMENTS OF THE RECTANGULAR FIELD POWDER MAGAZINE; AND THAT THE CONSTRUCTION MAY BE SOMEWHAT MODIFIED.

The first rectangular field powder magazines, made at Chatham, for the sake of experiment,* were reveted interiorly with gabions and fascines; and as the same materials may be substituted, instead of regular frames and sheeting on service, if a scarcity of wood-work should occur; it is proper to describe this arrangement, which will not be done so

* In 1828, at the suggestion of Captain Edward Matson, then Adjutant, and second in command.

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much in detail as usual, the former construction being followed, so far as the difference of the materials used will permit.

*First.—Quantity of Materials necessary.*

| | | |
|---|---|---|
| Gabions | | 24 |
| Fascines, to be cut to lengths | | 12 |
| Fascine pickets, bundles of | | 2 |
| Splinter proof timbers, 6 by 9 inches, and | 7 feet long, from 4, to | 7 |
| | 10 feet long | 21 |
| | 13 feet 6 inches long | 9 |

*Secondly.—Weight of the above, and Number of Men necessary for carrying them.*

The above materials will probably weigh about 68 cwt. and may be carried by 144 men, that is under the supposition that there shall be one man to each gabion, two men to each of the shorter splinter proofs, and three men to each fascine, and long splinter proof timber.

*Thirdly.—Number of Men, Tools, and Implements.*

| | |
|---|---|
| 10 men. | 2 mauls. |
| 10 pickaxes. | Tracing line. |
| 10 shovels. | 2 six feet rods. |
| 2 rammers. | One bundle of tracing pickets (25 in number). |
| 2 handsaws. | |

*Fourthly.—Of the Tracing.*

The body of the magazine and passage may agree nearly with the dimensions laid down for the former construction, after the gabions shall be placed; but as these occupy 2 feet each way, about 4 feet more must be added to the length and width of the excavation for the body of the magazine, and to the width of the excavation for the passage. The former may therefore be made 15 feet 6 inches long by 9 feet 6 inches wide at bottom, and the latter may be made 6 feet wide at bottom; and all these excavations may be made to increase towards the top, by about 6 or 9 inches on each side, in order that the gabions may stand with a slope. The angular trench of communication may be traced about 5 feet 6 inches each way, from the rear and ends of the great rectangle, marked out for the body of the magazine, which after the gabions shall be placed, will assimilate to the distance of 7 feet, allowed in the former construction.

In making the gabion field powder magazines, now alluded to, we generally rounded off the two angles of the above trench in rear, as shown in the annexed figure, which fully explains the original tracing, although it contains a number of lines, which for that purpose alone would be

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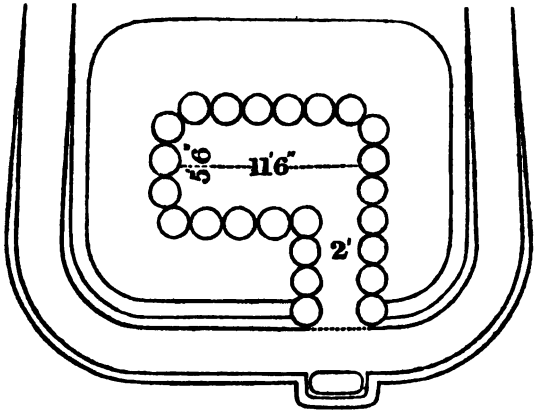
superfluous, it being the plan, in outline, of the finished magazine, but with the top removed, so that of the upper part, the base only of the parapet, or mass of earth forming the roof, is seen.




*Fifthly.—Execution of the Work.*

The ten men are all employed at first as diggers, namely, 6 in the body of the magazine, 1 in the passage, and 3 in the returns or extremities of the trench of communication. When the body and passage are excavated to the proper depth of 4 feet, they will all bring up and place the gabions, and afterwards the fascines and splinter proof timbers.

In order to raise the interior of the magazine to the proper height of 4 feet 6 inches, and to afford a support for the splinter proof timbers, the fascines are laid longitudinally, in two courses of 2 fascines each, and picketted down, over the tops of the several lines of gabions all round, excepting only in that part of the passage, which is in rear of the body of the magazine. There one course of two fascines only is laid over the gabions longitudinally on each side; and upon these two parallel courses of fascines, short splinter proof timbers, not less than four, and which need not exceed six or seven in number, are placed transversely over the passage, which they cover at least partially. These are intended to perform the same office, as the capsills of the passage frames in the former construction, namely to support the rear ends of the long splinter proof timbers, that are afterwards to be laid over all.

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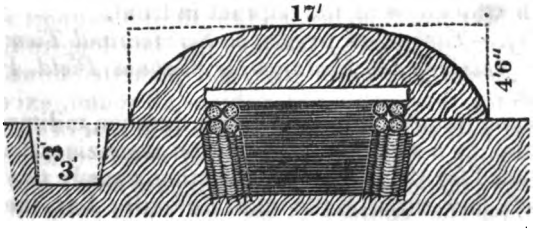
After the above arrangements of covering the gabions with fascines, and the passage with short splinter proofs, shall have been completed, the earth is made good on all sides of the body and passage, nearly to the same level as the top of the fascines, and rammed ; and the whole of these excavations are covered by the regular splinter proof timbers in the usual manner, all placed at right angles to the sides of the body of the magazine, the short timbers of 10 feet in length, with their ends projecting equally on each side beyond the excavation, and the long timbers of 13 feet 6 inches being made to aline with the others in front.

In finishing the magazine, 2 men must be employed in ramming, whilst the others act as shovellers and diggers, until the splinter proof timbers shall be covered with earth to the extreme height of about 4 feet 6 inches in the center, and of 4 feet at each side, above the original ground level. This mass of earth is rounded at the front angles, as well as in rear, the exterior slopes all round being laid out nearly at an angle of 45 degrees. Hence if the crests of the slopes be rounded a little at top, which was our usual practice, in finishing the gabion field powder magazine, the roof thus formed has the appearance of a kind of dome, the base of which was shown in the foregoing plan (page 202). The sesspool is made in rear of the entrance, as was represented in the same figure.

For the further illustration of this construction, three more figures are annexed. The first is a transverse section taken through the body of the magazine, and the trench of communication in rear, at a part where the latter is 3 feet deep.




The second is a section parallel to the former taken through the passage, one side of which is seen in elevation, and also through the trench in rear, which at this part is 4 feet deep. The short timbers over the passage are shown in transverse section, whilst one of the long splinter proofs, which they support, appears at full length.

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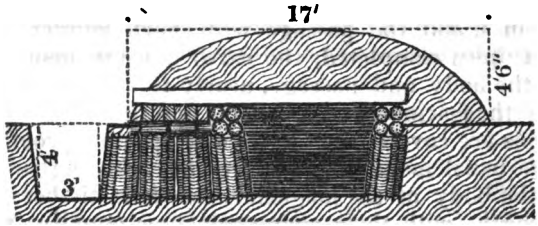
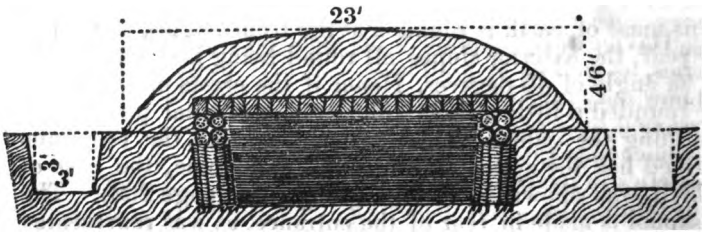



The third, is a longitudinal section, taken through the body of the magazine, and also through the returns of the trench of communication, on each side of it. In this figure, the splinter proof timbers of the body and passage are shown in transverse section.




The roof or parapet represented in the foregoing sections, and measuring at the base 23 feet by 17 feet, may sometimes exceed the latter dimension, on account of the circumstance before explained, that the two ramps of communication may sometimes require to be made trenches of uniform depth; and the earth thus obtained can only be disposed of, by adding to the thickness of the parapet in front.

*Sixthly.—Task-work proper on Service, and Time necessary, for finishing the Rectangular Gabion Field Powder Magazine.*

The same number of reliefs of the common military working parties in a siege, will finish this magazine, that were recommended for the former construction, namely two reliefs in easy soil, and three in the most difficult; but they will not accomplish it in the same time, because a greater excavation is necessary, to make room for the gabions. Even with the best workmen, it will require from one to nearly two hours longer, than the former, according to the nature of the soil.

It is true, that the increased number of 12 or 13 workmen might finish this magazine, as soon as the former can

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be finished by 10 men, but this arrangement could not save a relief of workmen; and therefore such increase of the number employed would be rather prejudicial than useful.

## SECTION XII.

### GENERAL VIEW OF THE EQUIPMENT AND ARRANGEMENTS, OF THE ARTILLERY FOR A SIEGE.

#### 1. PRELIMINARY OBSERVATIONS.

Having fully explained the construction of regular batteries, as well as of platforms, and field powder magazines, it now only remains to treat of the varieties, that may be occasioned by irregularities of ground, or by the necessity of commencing gun batteries by the sap; and also of certain varieties in the construction of gun platforms, that were before alluded to. But before I proceed to these details, which will complete this essay, so far as the duties of Engineers alone are concerned, it seems advisable to devote one section to a general view of the equipment and employments of the Artillery, without entering into which, the student of siege operations would form a very imperfect view of this great subject.

After a siege is determined upon, one of the most important objects of consideration, is to decide upon the quantity of ordnance and ammunition, which it is desirable to use, and on the means of transporting it from the coast, or other place or places, where the chief depots are formed, to the scene of action, whether by water or land carriage, or both. When the means of transport abound, it may sometimes be proper to overwhelm an important fortress by excess of artillery. When those means fall short, as was usually the case in all the inland sieges undertaken by the British army, in the Peninsular war, it may often be absolutely necessary to act with a much smaller quantity of ordnance and ammunition, than would otherwise be desirable.

The most valuable information upon these matters, is that which has been collected by Colonel Jones, in the second edition of his Journals of the sieges in Spain, in

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which the operations not only of the Engineer but of the Artillery departments are treated in detail; and both of which, but more especially the former, were embarrassed by so many difficulties, as must impress any well-informed and candid military man, who shall read these operations hereafter, with a favourable opinion of the personal merit of the officers of both services, whose efforts so frequently led to success, in spite of all those difficulties.

It is not however to be denied, that by far the most formidable, the most appalling obstacles, to the success of the siege operations of the British army, in the wars that arose out of the first French revolution, were neither occasioned by the difficult nature of the countries, that were the seat of war, nor by the vigour of the enemy; but by the defective arrangements made at home, owing to the nature of those important and arduous operations, not having been properly appreciated, until towards the close of those wars, by the military authorities, whose province it was to decide upon them. It is proper, that this should be fully understood, to prevent the same evils from recurring again, to the prejudice of the service. The fact is clearly implied, in the very able and useful work above-mentioned. To enlarge further on a subject, that belongs to military history, would be superfluous in an essay on batteries.

## 2. OF THE ORDNANCE AND AMMUNITION PROPER FOR THE SERVICE OF A SIEGE; OF THEIR RESPECTIVE WEIGHTS; AND OF THE NUMBER OF HORSES NECESSARY FOR TRANSPORTING THEM. REMARKS ON THE COMPARATIVE VALUE OF DIFFERENT PIECES OF SIEGE ORDNANCE.

*First.—Of Siege Ordnance. Ammunition, &c.*

I have deemed it most convenient to state the weights, &c. of the several pieces of ordnance and of their ammunition, that are suitable for sieges, in the form of a table, in which it will be observed, that the weight of each kind of mortar includes also that of its bed; because mortars have no travelling carriages like guns and howitzers, but are carried on extra carriages called platform carriages. The 13 inch mortar ought to have 1 platform carriage, and its bed another, making 2 carriages to each mortar of this description. Every other iron mortar and its bed may be transported conveniently on one platform carriage. The brass mortars and their beds may be packed, several of each in one waggon, like other light stores.

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The powder for mortars and howitzers includes not only the charge for firing, but also for bursting the shell, calculated for greater ranges than are likely to be generally required in a siege: and the powder for iron guns is in like manner calculated for the full service charge, being also more than is generally necessary, excepting for counter batteries, or for breaching batteries. This has been done to allow for waste or damage.

The number of horses for transporting the pieces of ordnance is estimated at the rate of about 5 cwt. to each horse, being rather more than the weight allowed in the transport of field artillery, which has not only to march over very rough roads in difficult countries, but leaving the roads altogether, to take up positions with great rapidity in broken ground. In respect to the number of horses for transporting the ammunition, I have also estimated at the rate of 5 cwt. per horse, which will amount in reality to 6 cwt. including the weight of barrels, boxes, &c. in which it is packed, and which cannot well be estimated at less than one-fifth part of the nett weight of the ammunition itself.

*Table of the Weight of Siege Ordnance and Ammunition, and Number of Horses required for drawing them.*

| NATURE OF ORDNANCE. | Weight of Piece. cwt. | Horses to draw it. No. | Shot or Shell. lbs. | Powder for one Round. lbs. | Total Weight of one Round. lbs. | Nett Weight of 1000 Rounds. cwt. qrs. | Horses to draw 1000 Rounds No. |
|---|---|---|---|---|---|---|---|
| *Iron Mortars.* | | | | | | | |
| 13 inch and its bed..... | 69½ | 14 | 198 | 14 | 212 | 1892 3 | 379 |
| 10 inch and its bed..... | 33 | 6 | 98 | 7 | 105 | 937 3 | 188 |
| 8 inch and its bed..... | 16 | 4 | 44 | 4 | 48 | 428 2 | 86 |
| *Brass Mortars.* | | | | | | | |
| 5⅕ inch and its bed.... | 2½ | ,, | 15 | 1½ | 16½ | 147 1 | 29 |
| 4⅖ inch and its bed.... | 1½ | ,, | 8 | 1 | 9 | 80 1 | 16 |
| *Iron Howitzers.* | | | | | | | |
| 10 inch ..... | 40 | 8 | 98 | 7 | 105 | 937 3 | 188 |
| 8 inch ..... | 21 | 4 | 44 | 6 | 50 | 446 2 | 89 |
| *Iron Guns.* | | | | | | | |
| 24 pounder, 9 feet..... | 48 | 10 | 24 | 8 | 32 | 285 3 | 57 |
| 18 pounder, 8 feet..... | 38 | 8 | 18 | 6 | 24 | 214 1 | 43 |
| 12 pounder, 8 feet..... | 30 | 6 | 12 | 4 | 16 | 142 3 | 29 |

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*Secondly.—Of the comparative value of different Pieces of Siege Ordnance.*

By examining the above, it will be seen that a 13 inch mortar not only requires twice as many horses to transport it as any other mortar, but that its ammunition weighs more than twice as much as one round for a 10 inch mortar, and more than four times as much as one round for an 8 inch mortar, and about seven times as much as one round for a 24 pounder breaching gun; and the shell alone is beyond the power of one man to manage conveniently. This excessive unwieldiness of the mortar itself, and prodigious weight comparatively speaking, of the ammunition required for it, may be considered as insuperable objections to the use of the 13 inch mortar for inland movements.* Having stated so much, it may seem almost unnecessary to point out the importance, of considering the comparative weights also of the other several pieces of ordnance; but the same may probably be deemed an inducement to use 8 inch rather than 10 inch mortars and howitzers; as the question does not consist in which weapon of the two singly is the most effective; but whether two 8 inch shells with their ammunition, which weigh less, may not be more effective, than one 10 inch shell.

In respect to guns, the iron 24 pounder has been proved to be so much more effective than the 18 pounder, for breaching; that it is now generally allowed, that it is better, all circumstances considered, to use the former in preference to the latter, although the 18 pounder itself can be moved with greater facility, and one third more of 18 pounder ammunition can be carried by the same means of transport. The 12 pounder is unfit for breaching: but it has been proposed as an useful aid in a siege, for enfilading, and also for counter batteries, for which latter purpose it will be most useful towards the close of the operations, after the enemy's heavy artillery shall be dismounted. The 24 pounder and the 12 pounder may also be used as howitzers, for throwing 5½ and

* If the chief object of the fire of mortars in a siege were to break down and destroy bombproofs or substantial buildings by repeatedly falling on them, the 13 inch mortar from the great momentum of its shell would be by far the most effective: but the explosion of a powder magazine in a fortress rarely takes place, and when it does, it is more often occasioned by accident, than by the premeditated fire of the besiegers. All mortars are annoying to an enemy, even Royals and Coehorns, for shells weighing 16 or even 8 lbs. are not to be despised. In respect to hand grenades, it being impossible to throw them by the hand on level ground so far, that the splinters after bursting shall not come back to the spot from whence they are thrown, it appears to me, that they are best adapted for the defence of works of fortification against a sudden assault, by throwing them over the parapet amongst the assailants, when in the ditch.

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4⅘ inch shells, or spherical case shot; whereas the shell, that may be thrown from an 18 pounder, does not suit the bore of any mortar used in the service. The iron howitzers recently introduced* are considered a great improvement upon the brass howitzers formerly used, the latter metal being only fit for field pieces or light mortars; because heavy brass ordnance will not only open at the vent, but even alter the form of the bore, in consequence of the intense heat occasioned by continued quick firing, with large charges of powder; whereas heavy iron ordnance will open at the vent only.†

3. GENERAL RULES, THAT MAY BE FOLLOWED IN DETERMINING THE PROPORTION OF ORDNANCE AND AMMUNITION FOR A SIEGE. ESTIMATE OF A BATTERING TRAIN OF 100 HEAVY PIECES OF ORDNANCE, AND 40 LIGHT BRASS MORTARS.

*First.—General Principles.*

Having consulted some of the most distinguished Officers of the Royal Artillery, who entered into this important subject with the full benefit of the experience of all our late wars; I have ascertained, that they consider the following proportions of the several pieces of ordnance, that may be employed in a siege, to be the most suitable, viz:

That in every battering train, there shall be 6 heavy iron guns to 4 heavy iron mortars, with a proportion of light brass mortars.

*Heavy Guns.* Of the guns, they would prefer all to be iron 9 feet 24 pounders in a small siege equipment, but in a large one, they would have two-thirds only 24 pounders, whilst the remaining third should consist of iron 8 feet twelve pounders.

*Heavy Howitzers and Mortars.* About three-eighths of the whole number to be howitzers, five-eighths to be mortars.

*Heavy Howitzers.* About one-third of the whole number to be 10 inch, and two-thirds to be 8 inch howitzers.

* By Major-General Millar, of the Royal Artillery.

† See a book entitled "a few Observations on the mode of Attack and "Employment of the heavy Artillery at Ciudad Rodrigo, Badajoz, &c." published in 1819, "by an Officer of Artillery," (known to be Colonel Sir John May,) which is full of useful and interesting information, on the employment of Artillery in Sieges. Sixty-eight pounder carronades were used at St. Sebastian, and are capable of throwing 8 inch shells as well as shot, but no carronades of any kind, nor any guns heavier than 24 pounders, have been considered suitable for inland operations, although they are well adapted for the service of the Royal Navy. Eighteen pounders were used as a battering train in the Peninsular war.



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*Heavy Mortars.* About three-eighths of the whole number to be 10 inch, and five-eighths to be 8 inch mortars.

*Light Brass Mortars.* In a large siege equipment, to be equal in number to the heavy howitzers and mortars, and to be composed one half of Royals and one half of Coehorn mortars.

In a smaller siege equipment, rather to exceed the number of heavy howitzers and mortars, but in the smallest, not to consist of fewer than 12 pieces, all of which should be Royals.

*Secondly.—Estimate of a Battering Train of* 100 *pieces of heavy Ordnance, and of* 40 *light Brass Mortars.*

According to the above rules, a battering train of the number of pieces of ordnance that has just been mentioned, and which the Officers, on whose authority I give these details, consider as being adequate to the attack of a fortress of the second class, will be composed as follows.

Forty twenty four pounders, to have each 1000 rounds of shot, 50 rounds of common case shot, and 100 rounds of spherical case shot, 1150 rounds in all.

Twenty twelve pounders, to be supplied with the same ammunition as the above, but with 200 rounds more of shot, making 1350 rounds of ammunition for each.

Five ten inch howitzers, to have each 600 shells, 10 carcasses, 100 proportions of Valenciennes composition, making 610 rounds for each.

Ten ten inch mortars, to be supplied with the same ammunition as the above, but with the addition of 50 rounds of one pound shot making 660 rounds for each.

Ten eight inch howitzers, also to have each 600 shells, one half of which to be common the other half spherical, a rule recommended always to be adhered to, for these howitzers, which are also each to have 10 carcasses, making 610 rounds in all.

Fifteen eight inch mortars, each to have 600 shells and 10 carcasses, making 610 rounds in all.

Twenty Royals or $5\frac{1}{2}$ inch mortars, each to have 200 shells, and 20 Coehorn or $4\frac{2}{5}$ inch mortars, each also to be supplied with 200 shells.

Spare gun and howitzer carriages in the proportion of one in ten; besides spare wheels and axle trees for all gun and howitzer carriages in the same proportion, but in the proportion of one in twenty only for their limbers.

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*Thirdly.—Abstract of the above Battering Train, with the number of Horses necessary for transporting it, exclusive of the Ammunition, and spare Carriages, &c.*

| NUMBER AND NATURE OF ORDNANCE. | Number of Horses for each. | Total Number of Horses. |
|---|---|---|
| 40 twenty-four pounders ..... | 10 | 400 |
| 20 twelve pounders ..... | 6 | 120 |
| 5 ten-inch howitzers ..... | 8 | 40 |
| 10 ten-inch mortars ..... | 6 | 60 |
| 10 eight-inch howitzers..... | 4 | 40 |
| 15 eight-inch mortars ..... | 4 | 60 |
| 20 Royal ($5\frac{1}{2}$ inch) mortars ..... | .. | 10 |
| 20 Coehorn ($4\frac{2}{5}$ inch) mortars .... | .. | 6 |
| Total Horses.... | | 736 |

*Fourthly.—Abstract of Ammunition for the above, and of the Number of Horses for transporting it.*

| NUMBER AND NATURE OF ORDNANCE. | Rounds for each. | Rounds of Ammunition for the whole. | Nett Weight of Ammunition. cwt. | qrs. | Number of Horses at 5 cwt. each. |
|---|---|---|---|---|---|
| 40 24 pounders..... | 1150 | 46,000 | 13,142 | 3 | 2,629 |
| 20 12 pounders..... | 1350 | 27,000 | 3,857 | 0 | 772 |
| 5 10-inch howitzers.. | 610 | 3,050 | 2,860 | 0 | 572 |
| 10 10-inch mortars .. | 660 | 6,600 | 6,187 | 2 | 1,238 |
| 10 8-inch howitzers.. | 610 | 6,100 | 2,723 | 0 | 545 |
| 15 8-inch mortars .. | 610 | 9,150 | 3,921 | 2 | 784 |
| 20 $5\frac{1}{2}$ inch mortars.. | 200 | 4,000 | 589 | 1 | 118 |
| 20 $4\frac{2}{5}$ inch mortars.. | 200 | 4,000 | 321 | 1 | 64 |
| Total.... | | 105,900 | 33,602 | 1 | 6,722 |

*Fifthly.—Remarks.* It will be understood, that whenever so many rounds per gun or mortar are stated in general terms, to give a notion of any particular siege equipment, it implies round shot, and shells, not including grape or tier shot, spherical case, carcases, &c., unless it be particularly specified to the contrary.

For the attack of a first rate fortress, it is recommended on the same authority, not only to augment the quantity of ordnance, but the ammunition, allowing 1500 rounds for



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each 24 pounder, 1800 rounds for each 12 pounder, and 900 shells for each heavy mortar, being at the rate of one half more than the above: and at the same time to increase the quantity of carcases, case shot, small shells, &c. &c., in the like proportion.

On the other hand, it is suggested that for the attack of a third rate fortress, the smaller proportion of 500 rounds for each heavy gun, and of 300 rounds for each heavy mortar may suffice, at the same time, that the number of pieces of ordnance may be reduced.

To the quantity of powder, estimated as before explained, it is recommended that two or three barrels of fine grained powder shall be added, for each heavy piece of ordnance, besides a small proportion of mealed powder, about 1 lb. per piece.

The above are the most important articles of an artillery siege equipment, to which however must be added side arms for the guns and mortars; ingredients for laboratory compositions, and a number of laboratory stores and implements, such as portfires, slowmatch, quickmatch, fuses, weights, measures, quadrants, &c. &c.; also tools for smiths, wheelers, coopers and other artificers; machines or mechanical powers such as gyns, tackles, sling carts &c.; together with trench-carts and hand-carts, to be used in the conveyance of stores to the trenches, after the siege is commenced. Besides the platform waggons for mortars, before mentioned, artillery store waggons, termed Flanders waggons, for conveying the most important stores for immediate service, and each drawn by four horses, would probably accompany the battering train; in the proportion of one waggon to each heavy piece of ordnance. Spare wheels and axle trees should likewise be provided for the waggons, &c.

Thus the above pieces of ordnance drawn by 736 horses, would have 100 Flanders waggons attached to them, drawn by 400 horses, making 1136 horses, in all, exclusive of those employed with forge waggons, which are also an indispensable part of every artillery equipment.

It is desirable, that the whole of the above ordnance for the siege of a fortress, as well as the stores contained in the waggons should be on the spot, at the opening of the trenches, in order to arm the first batteries; but as a siege is a work of time, which is subject to calculation, the great mass of ammunition, need not be brought up all at once, but in several successive journeys, the horses employed going backwards and forwards, so that fewer than the number estimated in the foregoing tables would suffice.

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The field artillery of an army should always be drawn by regular artillery drivers and horses, and this is no doubt the most efficient mode of transport that can be adopted; but in preparing for a siege, it has generally been necessary to have recourse to the resources of the country, that is the seat of war, previously organized, for the conveyance of the greater part, if not of the whole of the battering train and ammunition required.

It may be remarked, that in good roads each horse may draw more than 5 cwt. of nett, or 6 cwt. of packed ammunition, at which rate I have estimated in the preceding table, and which I consider practicable in very bad roads. But if bullock carts only can be obtained, as in Portugal, and in the mountainous parts of Spain, and if the roads also be bad, as was the case there, each bullock will only be able to draw 3 cwt. making 6 cwt. for the load of a cart. To arrange these matters well is one of the most important, though not the most brilliant duties of an artillery officer in command: and here also it is of the greatest importance to have an active and intelligent ordnance commissary, with an efficient establishment of clerks and conductors of stores.*

### 4. THE SAME SUBJECT CONTINUED. REMARKS ON THE BATTERING TRAIN, BEFORE DESCRIBED.

The battering train above recommended, consisting of 60 heavy pieces of cannon, with 73000 rounds of ammunition, and 40 heavy mortars and howitzers, with 24,900 rounds of ammunition, making 100 heavy iron pieces of ordnance, and 97,900 rounds of ammunition in all, exclusive of that for the 20 light brass mortars, appears to me to be a very respectable equipment, for on a reference to the journals of sieges in Spain, it will appear that the ordnance and ammunition for all of them fell greatly short of the above; since even in the attack of St. Sebastian the most vigorous of the whole, the means were much inferior; as the heavy ordnance in battery there only amounted to 53 pieces, and the expenditure of ammunition was rather less than 71,000 rounds, and these stores were not in readiness from the first, but collected by piece meal.

* One commissary, 3 assistant commissaries, of whom one for the shipping, one for the laboratory, and one for the park, with 8 clerks, and 8 conductors of stores, have been recommended as a good arrangement for a field train of Artillery, and 1 master artificer, (a wheeler) 5 wheelers, 7 blacksmiths, 5 collar makers, and 2 coopers, have been recommended as a proper number of civil artificers to accompany the train.

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Of all our British siege equipments, that for the attack of Bayonne alone was superior to the above estimate, since no less than 119 pieces of heavy ordnance, 20 coehorn mortars, and 166,324 rounds of ammunition were destined for that enterprise: and the engineer department was no less amply provided with all those means to insure a reasonable prospect of success, that were more or less deficient in the whole of the former sieges. The arrangements for this siege alone therefore deserve unqualified praise; but the war terminated before their merit was put to the test.

To return to the estimated battering train of 100 pieces of heavy ordnance and 40 light mortars, which formed the subject of the foregoing article, on comparing it with the reports of stores and ammunition provided for and expended, in six of the most memorable French sieges in the reign of Louis the Fourteenth as stated in the second volume of Cormontaigne's treatise on the attack of places, it will be seen, that although the estimated quantity of ordnance generally falls much short of the French siege equipments alluded to, yet that the estimated quantity of heavy ammunition has seldom been much exceeded, by the quantities actually expended in those sieges, some of which were of long duration. Now it is evident, that the effect, produced upon a fortress by the besiegers' batteries, depends more upon the number of well directed shot and shells poured into it, than on the number of pieces from whence they are discharged; and taking the difference between the two metals, I do not perhaps go too far in assuming, that 100 pieces of heavy iron British ordnance of the present day are equal in efficiency, to at least 120 pieces of the heavy brass French ordnance used in the time of Louis the Fourteenth. Upon the whole therefore, the estimated battering train under discussion appears to me capable of making an impression, even upon a respectable fortress. The number of shells for the small brass mortars, might however perhaps be more than doubled, or even trebled to advantage.

### 5. OF THE NUMBER OF GUNNERS NECESSARY FOR A SIEGE.

This depends upon the average number of pieces of ordnance, likely to be in action at the same time, and is estimated, by allowing 6 men for each 24 pounder gun and 10 inch howitzer, 5 men for each 12 pounder gun, 10 inch mortar and 8 inch howitzer, and 4 men for each 8 inch mortar; the light brass mortars, which would require only 2

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or 3 men being disregarded, as they are likely to be used only on particular occasions, and not daily throughout the whole siege.

Of the number of gunners, thus estimated, there should be three reliefs for a regular siege, but two might suffice for a short operation, exclusive of a reserve of one man in four or five, to provide for casualties, and also 50 men extra for laboratory purposes, and 12 men extra for military conductors. In besieging seaport towns, the navy are often employed to man a part of the gun batteries. In inland operations, when there is a want of artillery men, their place may be supplied by men from the infantry, who when mixed with skilful gunners will be quite efficient for the service of siege batteries.

### 6. OF THE DISTANCE MOST SUITABLE FOR GUN, HOWITZER, AND MORTAR BATTERIES, IN A SIEGE.

*First.—Of the Distance proper for Enfilading Batteries.*

The first batteries in a regular siege are generally enfilading batteries, for guns, howitzers, and mortars, in respect to the two first of which, ricochet firing is used.

In the ricochet practice, first carried on at Woolwich, on a great scale, and with live shells from the howitzers in 1821, in which 24, 18, and 12 pound-shot, and 10, 8, and 5½ inch shells were thrown; it was remarked in respect to the shot in particular; that at a range of 400 yards, and using a charge of powder of 1-32d part of the weight of the shot, two-thirds of the shot fired fell within the work enfiladed, which was the face of a bastion, about 100 yards in length: that at a range of 600 yards, and using charges of from 1-32d to 1-20th of the weight of the shot, two-fifths of the shot fired fell into the work: and that at a range of 800 yards, using charges of from 1-24th to 1-12th of the weight of the shot, rather less than two-fifths fell into the work. The best elevation for this kind of firing was from 6 to 9 degrees.

Hence ricochet batteries should be at a distance of 400, and not exceeding 600 or 700 yards from the work to be enfiladed; but more distant enfilading batteries are better than none, whenever insurmountable obstacles prevent them from being constructed so near to the fortress as could be desired, especially if the line to be enfiladed should be long.* The

* When the outline of any part of a fortress is broken into a number of very short faces, it is better to establish a powerful battery of general enfilade, than to attempt to enfilade such faces by a number of smaller batteries, directed against each.

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24 pound-shot used in ricochet batteries, will disable guns and gun carriages, and break down palisades. The common shells from howitzers and mortars will accomplish the same objects, besides producing the farther effect of gradually ruining earthen traverses, and more effectually injuring parapets. Spherical case shot, or Shrapnel's shells, and grape or tier shot, are the most annoying and destructive to troops manning the ramparts. Common shells filled with the full quantity of powder, when they burst after lighting on the ground, throw their splinters in all directions to the distance of nearly 400 yards. Hence a considerable proportion of the splinters from the shells of mortar batteries, situated at any considerable distance in front of the second parallel, are sure to come back to the spot from whence they were fired. For this reason it is best, that the advanced mortar batteries in a siege should either fire with reduced bursting charges, or should only throw volleys of one pound shot,* which have accordingly been provided for that purpose, in the siege equipment before detailed.

From personal observation, as a witness of the ricochet practice at Woolwich in the above year, I cannot say, that I observed the shot to graze more than once or twice at the utmost, within the space of 100 yards that was enfiladed, notwithstanding which inaccuracy as it appeared to me, in the description of this species of firing usually given in elementary books, I was impressed with a strong opinion in favour of the efficacy of this mode of attack, which as practised from a 24 pounder gun, at a distance not exceeding 700 yards, does not on an average consume more than one-sixth part of the powder required for direct firing with full charges.

*Secondly.—Of the distance proper for Direct Batteries of Guns or Mortars.*

In attacking any part of a fortress, every face of respectable length, that is capable of acting against the works of attack should be enfiladed if possible, by a battery constructed for the purpose; but as this is sometimes impracticable, or at least very inconvenient, those faces which cannot be enfiladed, must be counterbattered or opposed by the fire of a direct gun battery with full charges, aided by mortars.

* This weight is considered the most efficient by our Artillery, Carnot having been proved to be in error, in recommending 4 ounce balls to be fired from mortars. Round stones or boulders not weighing less than a pound, may be used for the same purpose, when they can be procured, as has often been done in sieges. Hence the term *Pierrier* or stone mortar, signifying one made on purpose for this kind of firing

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It is best that these batteries, like the enfilading batteries, with which they are connected, and which they are to support, should not exceed the distance of from 400 to 700 yards, from the works against which they are to act.* It is true that heavy mortars will throw their shells to a much greater distance, yet I conceive that the above ought not to be exceeded, because distant batteries are not only the most wasteful of ammunition, and injurious to the mortars, and platforms, but they cannot fail to give to your enemy, the unfavourable impression, that your measures are guided by ignorance or timidity.

*Thirdly.—Of the distance proper for Direct Breaching Batteries.*

Heavy guns may breach a revetment from the distance of 500, or 600 yards, or even more ;† but at shorter distances their fire produces a more powerful effect. In attacking a regular fortress, the breaching batteries must necessarily be placed on the crest of the glacis, or in the covered way at a distance seldom much exceeding 50 yards and the enemy's fire is usually silenced or kept under before they are commenced, notwithstanding which they are supported by counterbatteries, also placed on the crest of the glacis, to silence the fire of the flanks, or other works, that bear upon them, or that might act against the storming parties in the passage of the ditch.

But in attacking an irregular work, whose revetments are completely exposed to distant fire, I would not recommend breaching from a less distance than about 350 yards, it being unnecessary to expose your working parties whilst constructing the breaching batteries, or your artillery men, when they are completed, to a fire of musquetry, which would be the case, if you advanced them much nearer. This rule more especially applies to the attack of an ancient castle or large tower, or of a strong building, with massy walls, such as a convent, when occupied by an enemy. In attacking earthen works, which do not require to be regularly breached ; shells will ruin the slopes, and render them more accessible to the assailants ; and in attacking places fortified

* It usually happens in the attack of a regular fortress, that those guns which enfilade one face of a ravelin or bastion, are well situated for counter-battering the other face of the same work, if necessary.

† The revetments of Gaeta were breached by the French in 1806, from batteries situated at the unusual distance of about 1200 yards, probably owing to the nature of the ground, for they had actually pushed on their approaches by sap, working almost entirely by night, to within close musket shot of an extensive front well armed with ordnance, before those batteries opened.

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with mud walls, as in the east; howitzers will be more useful than guns for effecting a practicable breach.

In attacking an extensive fortress, although its revetments should be completely exposed to distant batteries, it would not be prudent to breach them, until you are ready to assault with a good prospect of success. The most eligible mode therefore is first to silent the enemy's fire by a judicious system of enfilading and counter batteries; and then to push your lodgments close up to the walls, before you complete your breaches, and give the assault.

*Fourthly.—Of the Distance proper for Breaching, by a Pitching fire of Artillery.*

This method tried for the first time against Carnot's wall, at Woolwich, in 1824, proved that revetments protected by earthen counterguards, or otherwise, and which consequently cannot be seen or injured by a direct fire of heavy guns at full charges, may be breached by a pitching fire of shot and shells, similar to that used in ricochet firing; and the same distances most suitable for the latter, namely, four or five hundred yards, are also the best for the kind of battery now under discussion.

This ingenious and novel mode of breaching would be very effectual against the mortar casemates in Carnot's systems, which it would probably destroy at an early period of the siege; and it is right that it should be thoroughly understood: but in many or perhaps in most other cases, I would prefer sapping up close to the works attacked, in preference to breaching them from a distance, by this method.

### 7. OF THE METHOD USUALLY EMPLOYED, IN CONVEYING GUNS AND AMMUNITION TO THE BATTERIES, IN A SIEGE.

The guns are usually conveyed in the night, and are drawn straight across the field, instead of moving them along the approaches. But in passing the first and second parallels, they must, after entering them, be drawn out again, through the next branch of the zigzags, immediately in front of each. In passing the third parallel, if there be only serpentine double saps in front, which may not always be convenient for the passage of guns, it may perhaps be necessary to cut openings in some part of the parapet, as well as to form temporary bridges over some part of the trench. A 24 pounder gun may be drawn by 10 or 12 horses as far as the first Parallel, or farther, if the enemy's fire should not be troublesome. In front of the first Parallel, it will be best

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to employ men, at the rate of about 50 to each gun of the above caliber.

The ammunition may be carried by men, in doing which hand barrows will be convenient, and for some kinds absolutely necessary; or it may be drawn by men in hand carts. That portion of it which consists of shot, and empty shells, may be conveyed in trench carts drawn by single horses, to the reverse of the first parallel, or even farther, if the enemy's fire should not be troublesome.

In employing military carrying parties, not previously inured to such labour, it is not prudent to calculate upon carrying weights at a much greater rate, than about half a hundred weight per man.

In carts, whether drawn by men or horses, it is well known, that the load must depend upon the nature of the road or ground, across which they are to move. If the trenches be hard and dry and without steep ascents, one may calculate upon 4 men drawing 10 or even 12 cwt. along them in a hand cart. If they be soft or with steep ascents, the load may either require to be reduced by one third, or even by one half, or the number of men to be increased to 6 or 8. Thus the load per man may vary from 1½ to 2 or 3 cwt. In like manner the load of a one horse trench cart may vary from only 5 or 6 to 10 or 12 cwt, according to the nature of the ground.

## 8. OF THE SERVICE OF GUNS, HOWITZERS AND MORTARS, IN A SIEGE.

It was before stated, that the full service charges for guns, employed in breaching or in counter batteries is always sent to the batteries in boxes, after having been previously made up into cartridges.

It was also before stated, that the powder for the service of mortar batteries has hitherto been always sent to the trenches in barrels, and deposited in the field powder magazines. These barrels are opened, one or two at a time, and the charges for bursting the shells, as well as for loading the mortars, are weighed or measured. The shells are filled with their proper bursting charges, after which the fuses, being previously cut according to the range, are fixed.

Notwithstanding the degree of risk, that must evidently attend the opening of powder barrels and the weighing or measuring of their contents, in the field powder magazines themselves; these delicate operations have generally been performed there, by the British Artillery; and working with

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that care and skill, by which they are distinguished, I am not aware that any accident ever occurred to them, whilst so employed.

Sometimes, however, the powder barrels have not been opened in the magazine itself, but have been carried from thence one or two at a time, to a second magazine at some little distance from the principal one, where they have been opened and the powder weighed and measured, shells filled, and fuses cut and fixed. The second magazine, used for this purpose, never having more than two full barrels of gun powder in it, at the same time, is termed the laboratory magazine, to distinguish it from the first, which is properly speaking the powder magazine.

Sometimes again, instead of employing a second magazine, the Artillery have performed the operations alluded to, in some sheltered corner of the trenches near to the battery, but at a little distance from the principal magazine, or in a recess at the end of a small trench cut for the purpose, and communicating with the battery, or with one of the boyaus, leading to it.

By working with loose powder exclusively in these laboratory magazines, or laboratory recesses, the latter of which should be covered by a tarpaulin, the consequences of accidental explosion can never be serious; for the probability is, that only one full barrel and a part of a second could be exposed to this risk, whilst the great mass of full barrels, contained in the powder magazine of the battery, would be perfectly safe.

Such has hitherto been the practice in the British Artillery, and there is certainly a great advantage in weighing or measuring the variable charges of guns employed in ricochet firing, and of howitzers and mortars, and in cutting the fuses for the latter on the spot, because in this case quantities of powder or lengths of fuses, if found too great or too small, can be corrected as required; whereas if these operations be performed at a certain distance in the rear, any error as to those points might affect the whole or a considerable proportion of the ammunition for one days firing, to rectify which would give infinite trouble, besides occasioning a prejudicial delay.

In respect to the bursting charges of shells, as there is little or no risk of error, fron making them up at a distance from the battery, I have been informed by some very distinguished Artillery Officers, that it is proposed in future to make up those charges in bags in the rear of the trenches,

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and to send them packed in boxes, to the field powder magazines of the batteries. When the howitzers or mortars are to be fired, the boxes will be taken out of the magazine, one at a time, and the shells will be filled at some distance from it, by pouring the contents of the bags into them, by means of a funnel, after which the fuses being cut to the proper lengths, will be fixed. At night the bags will be sent back empty in the same boxes, to be replenished in the rear. This will evidently be an improvement upon the former system.

9. OF THE AVERAGE QUANTITY OF AMMUNITION, THAT MAY BE FIRED DAILY, FROM THE ENFILADING OR COUNTER BATTERIES, BEING THE FIRST BATTERIES IN A SIEGE. NUMBER OF POWDER MAGAZINES NECESSARY FOR SUCH BATTERIES, IN REFERENCE TO THE ABOVE AVERAGE.

*First.—Average quantity of Ammunition.*

The ordnance from the first batteries may perhaps be required to make a more vigorous effort, on the day that those batteries open; but taking the average of the whole siege, neither they nor any of the other enfilading or counter batteries afterwards established, in more advanced positions, are likely to be required to fire so many as 100 rounds from each piece of ordnance, in any one day, 60 rounds being the more probable average, as estimated by Colonel Jones.

Assuming however, the greater number of these two, as the rate of daily expenditure, if we suppose a 24 pounder gun to be employed in a counter battery, and consequently to fire at full charges of 8 lbs. each, 100 rounds will be contained in ten powder boxes of the new pattern. Consequently, in reference to the capacity of the rectangular field powder magazine, before described, one of those magazines, which can contain 72 boxes, will hold enough of powder for one day's consumption of a counter battery of seven 24 pounders.

Next to the 24 pounder gun firing with full charges, the ten inch howitzer and mortar consume the most powder, the estimated quantity before stated being 7 lbs.; and if these pieces should continue to be served as hitherto, entirely or partly by loose powder instead of cartridges, it must necessarily be sent to the batteries in barrels. But as it was before stated, that one of the rectangular field powder magazines may contain 44 barrels of 90 lbs., or 3960 lbs. of powder in all; it follows that one of these magazines will hold powder enough for the daily consumption, of rather more than five but less than six of those pieces.

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By the same rule, this magazine will hold powder enough for the daily consumption of nearly seven 8 inch howitzers at 6 lbs., or of nearly ten 8 inch mortars at 4 lbs., or of 26 Royal mortars at 1½ lb., or of very nearly forty Coehorn mortars at 1 lb.

The same field powder magazine will hold one day's consumption for no less than twenty-eight 24 pounders, employed in Ricochet firing, at the ranges most proper for batteries of that description, which will not require average charges of more than 2 lbs. of powder.

Upon the whole, it may be assumed that one field powder magazine to every five or six heavy guns, mortars, or howitzers,* will be sufficient for all the enfilading or counter-batteries in a siege; for in this proportion, they will contain more than enough of gunpowder for one day's average consumption of those batteries; which is replaced at night, by bringing up a fresh supply of full barrels or boxes from the rear.

Generally speaking, two powder magazines should be made to each of the enfilading or counter batteries, as the number of pieces of ordnance is seldom less than eight, but scarcely ever exceeds twelve. If however any such battery should not contain more than 4 or 5 pieces of ordnance, it would be waste of labour, to provide it with more than one such magazine.

In addition to the proportion of field powder magazines that has just been stated, it may be necessary to construct, either one laboratory magazine, or one if not two laboratory recesses, to each enfilading or mortar battery.

## 10. OF THE QUANTITY OF AMMUNITION AND THE TIME NECESSARY, FOR BREACHING GOOD MASONRY BY BATTERING GUNS. OF THE NUMBER OF FIELD POWDER MAGAZINES PROPER FOR A BREACHING BATTERY. WEIGHT OF GUNS, AMMUNITION, &c. FOR EFFECTING A PRACTICABLE BREACH OF 60 FEET IN A STRONG REVETMENT.

*First.—Quantity of Ammunition and Time.*

From the experience of the sieges in Spain, it appears, that a practicable or thoroughly accessible breach, of any required extent, may be effected in very good masonry, from

* Provided that no 13 inch mortars are used, for these require so much powder, that there ought to be one powder magazine to every three 13 inch mortars, in order to hold one day's consumption of 100 rounds for a battery of such mortars.

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a distance not exceeding 500 yards, at the rate of 100 rounds to each running foot of revetment battered. Hence a practicable breach of 60 feet in extent in a good revetment would require 6000 rounds of a 24 pounder.* If therefore we suppose a battery of 10 guns of that caliber to be employed in breaching, each gun would have to fire 600 rounds to produce the above effect, which may be accomplished by a very vigorous exertion in two days, or by a more moderate one in three days.

*Secondly.—Number of Field Powder Magazines necessary.*

From the capacity of the rectangular field powder magazine, as stated in the foregoing article, a breaching battery of ten 24 pounders ought to have four such magazines attached to it, to contain the powder necessary for one day's consumption, in firing at the very vigorous rate of 300 rounds per gun per diem: but if it should only be required to fire at the rate of 200 rounds per gun per diem, three of those magazines will hold the powder necessary for one day's consumption.†

If fewer powder magazines be constructed for breaching batteries, than the above proportions involve, it will be necessary either to replenish them more than once in the twenty-four hours, or to relax from the above vigorous rates of firing.

*Thirdly.—Remarks.*

In battering revetments of inferior masonry, or of brick-work built with inferior mortar, one may calculate upon effecting a practicable breach at the rate of 75 rounds to each running foot of revetment, being three fourths of the quantity of 24 pounder ammunition required for good masonry. Perhaps even less might suffice, but it is not prudent in making preparations for a siege, to run estimates of this nature too low.

* This rule is deduced from a table of the measurements of nine breaches thoroughly accessible, and of the number of shot by which they were effected, and from what distances, in the Fortresses attacked by the British Army in Spain, as stated in Note 34, to the second edition of Colonel Jones's Journals, who observes, and I have heard his opinion confirmed by other Officers, who have seen both, that a much smaller expenditure of ammunition would breach the common brick revetments of the Fortresses of France and Flanders, than was necessary in Spain.

† At St. Sebastian, 300 rounds a day were fired from each of the breaching batteries, which may be considered an extraordinary exertion, as compared with the practice of former wars. The continental nations never accomplished so much, probably owing to their using brass battering guns, which are comparatively inefficient, as was before observed. Sir John May is of opinion, that 500 rounds may be fired in one day. See the Book before quoted in the Note to page 209.

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In besieging a well constructed fortress, the pieces of ordnance in the first batteries, which are situated near to the first or second parallels, are of course afterwards moved forward to arm the breaching and other more advanced batteries, which must necessarily be constructed upon the crest of the glacis. In thus disarming the more distant batteries, it may be of the greatest use, to allow a part of their field powder magazines to remain untouched, which may serve as safe and convenient intermediate depôts of powder between the park of Artillery and the breaching batteries.

*Fourthly.—Weight of Guns, and Ammunition, and of Platforms, and Magazine Timbers, to complete a Battery, for effecting a practicable Breach of 60 feet in a Revetment of good Masonry.*

| | CWT. | QRS. | LBS. | CWT. | QRS. | LBS. |
|---|---|---|---|---|---|---|
| 10 twenty-four pounders, at 48 cwt. | 480 | 0 | 0 | | | |
| 6000 shot at 24 lbs. | 1285 | 2 | 24 | | | |
| 6000 charges of powder, at 8 lbs. | 428 | 2 | 8 | | | |
| 600 powder boxes, at 23 lbs. | 123 | 0 | 24 | | | |
| Total weight of ordnance and ammunition, cwt. | | | | 2317 | 2 | 0 |
| 10 platforms, at 13 cwt. 2 qrs. 23 lbs. | 137 | 0 | 6 | | | |
| 3 sets of magazine timbers, at 47 cwt. 1 qr. 2 lbs. | 141 | 3 | 6 | | | |
| Total weight of platforms and magazine timbers | | | | 278 | 3 | 12 |
| Grand total, cwt. | | | | 2596 | 1 | 12 |

*Fifthly.—Number of Men to transport the above.*

To carry the platforms and magazine timbers will require 593 men; to drag the guns, 500: to carry the shot 2000 men: and to carry the boxes filled with the powder in cartridges 1200 men: making a total of 4293 men; that is to do the whole at one journey. But if we suppose, that the breach is to be effected in three days firing, the ammunition may of course be divided into three parts, and one portion sent daily; the shot in the day time, the powder which is attended with some risk of explosion, by night, to escape the observation of the enemy.

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This being premised, if we further suppose, that depots of shot have been established in the first parallel, and depots of powder in the field powder magazines of the first batteries, as was before suggested, about 220 men employed in any one day will bring up shot enough to the breaching battery for the next days' firing in four journies: and 200 men employed in one night will bring up a sufficiency of full powder boxes for the next days' firing in two journies.

REMARKS. In this article, we have only treated of a single breaching battery, of which there would be several towards the close of a siege, supported by counter batteries; and the latter also would require no small labour to bring up their stores. But to investigate the service of Artillery in further detail, would be superfluous. Enough has now been said, to give an idea of the vast magnitude and multiplicity of the means, which that important arm ought to possess, and of the multifarious arrangements necessary to transport them to the scene of action at the proper periods, and to provide against the delay or confusion that might be occasioned by the deficiency of any store, or by the mixing or mis-sending of ammunition. Upon the whole, considering the very great number of objects that are to be provided for, the minuteness of some, the magnitude of others, and the pernicious effects that might result from an oversight or neglect in respect to any; it may be allowed, that the duties of the Artillery in a siege are by no means an easy or an every day task.

## SECTION XIII.

### OF THE VARIETIES IN THE CONSTRUCTION OF BATTERIES, THAT MAY BE RENDERED EXPEDIENT, BY IRREGULARITIES IN THE NATURE OF THE GROUND, &c.

#### 1. PRELIMINARY OBSERVATIONS.

In the foregoing parts of this Essay, batteries have been described, such as are proper for the attack of a fortress, situated upon a plain, with its guns having that moderate command of 7 or 8 yards only, over the surrounding country, which is seldom exceeded in regular fortification, and in



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reference to which the profiles of those batteries were determined; whilst the ground being by supposition not only level, but unobstructed; the face of each battery has been laid out perpendicularly to the direction in which it was to fire.

The above being therefore the regular or elementary construction of batteries, it now remains to treat of the varieties, which may be rendered necessary by various circumstances, chiefly connected with the nature of the ground.

I shall first however repeat a caution before stated, that ought never to be lost sight of in irregular ground, in determining the position of gun batteries for direct firing, that is to kneel or lie down, in looking towards the fortress, according as the proposed direct gun battery is to be elevated or sunken, in order to guard against those small inequalities of ground, that cannot be judged of standing. *(See page 119).*

It is further proper to premise, that in all the examples of irregular ground, about to be laid before the reader, extreme cases have been chosen, as being best adapted for illustrating the practical rules, that ought to be followed in respect to each variety.

## 2. OF THE PROFILE PROPER FOR BATTERIES SITUATED ON GROUND COMMANDING THE FORTRESS.

***First.—When the Battery, which commands the Fortress is itself situated on Level Ground.***

In this case, the enemy's shot will clear the parapet of the battery at an angle of elevation, so that there may be as much cover at the tail of the platform, as in front. The interior height of the parapet may therefore be reduced from the standard of 7½ to 7 feet; and its exterior height may be reduced from the standard of 6 feet, in the same or even in a much greater degree, in proportion to the command, and the extent of the base of the parapet will also be diminished in consequence. Hence less labour is necessary for constructing a battery on high but level ground, against a fortress commanded by it, than under ordinary circumstances.

To exemplify this construction, the profile proper for a battery having a command of 1 foot in 5 over the fortress, is represented in the annexed figure, in which the larger profile proper for a common battery, not having any command over the enemy's works, and only moderately commanded by them, is dotted.

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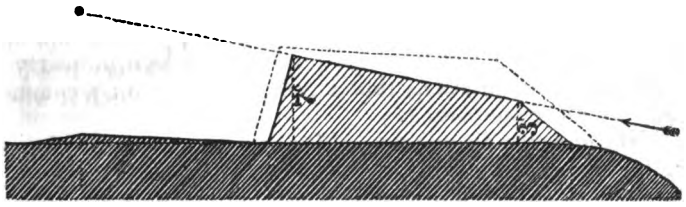

The path of a cannon ball supposed to be fired from the fortress against the commanding battery, at an elevation of about 1 foot in 5, is denoted by an arrow, in the usual manner. The exterior slope of the parapet is made nearly to agree with the enemy's line of fire, instead of having a certain dip below it, for it seemed useless to reduce the exterior height of the parapet to less than 3 feet, the dimension shown in the figure.

It may perhaps appear scarcely necessary to remark, that our present supposition implies, that the position chosen for the battery must necessarily be at the front of the high level, and near to the commencement of the declivity or fall of the ground, towards the fortress; for if it were retired farther back, the brow of the height at the meeting of these two planes would intercept the view of the works of the fortress, and impede the direct fire of the battery.

*Secondly.—When the commanding Battery is situated on a Descending Slope.*

In this case, the interior height of the parapet may be reduced to 7 feet, as in the former supposition, and the exterior height in reference to the horizon may also be reduced: but by reason of the descending slope, this does not produce the same saving of labour, as in the former supposition, for the fall of the ground necessarily increases the exterior height of the parapet, in reference to the surface immediately beneath the crest of it, and still more in reference to the foot of the exterior slope; which increase of height of course causes a proportional increase of the base of the parapet: but the unfavourable effect of falling ground will be exemplified in the following article.

### 3. OF THE PROFILE PROPER FOR BATTERIES ON A DESCENDING SLOPE, WHEN NEARLY ON THE SAME LEVEL WITH, OR ONLY MODERATELY COMMANDED BY THE FORTRESS.

Supposing the descending slope to fall towards the front at the rate of 1 foot in 5, as the fortress is by supposition on



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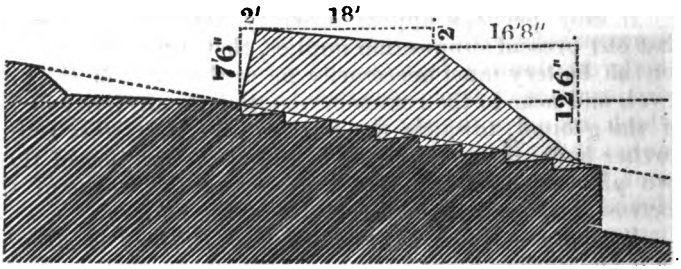
the same level nearly with the proposed situation of the battery; it follows, that the parapet ought to have the same total relief of 7 feet 6 inches, and the same dip nearly in reference to the horizon, that would be proper for a common battery not commanded.

The annexed figure exemplifies this construction. Agreeably to the above rule, that part of the parapet, which is above the dotted horizontal line drawn through the foot of the interior slope is nearly equal to that of a common battery, on the same level with the works of the fortress, but constructed on level ground: whilst the formation of the triangular portion of parapet below that horizontal line is all extra labour, occasioned by the fall of ground towards the front, as alluded to in the second supposition of the foregoing example.




Owing to this unfavourable circumstance, the exterior height of the parapet, which on level ground need not exceed 6 feet, is increased to more than double that dimension, and the extent of ground covered by the base of the parapet, is increased from 28 to nearly 37 feet.

In forming a parapet on an inclined plane, whether descending or ascending, it is necessary to roughen the slope, or to cut it into steps as shown in the above figure, in order to prevent the made earth from sliding down the slope, which if that precaution be neglected, is very likely to take place after rainy weather.

The above represents an elevated battery, in which a small portion of the interior is necessarily cut away, in consequence of the rise of ground towards the rear. A careful inspection of the figure will prove, that it would be more advantageous to sink the base of the interior slope about 1 foot, and thus to give to the profile more of the character of a sunken battery, than is shown in the figure: but it requires

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judgment to determine how much the interior may be sunk, upon ground of this description; for if it be cut deeper than a certain limit, the parapet may be finished, before the trench in rear is wide enough for the service of the guns.

It will now be evident, that a descending slope is an unfavourable position for a battery, as it involves more labour, than will suffice on level ground.

### 4. OF THE PROFILE PROPER FOR BATTERIES, CONSIDERABLY COMMANDED BY THE WORKS OF THE FORTRESS.

*First.—When the Battery commanded by the Fortress is situated on a Descending slope.*

It was shown in the preceding article, that the formation of a battery on a descending slope, even when commanded very moderately or not at all, involves much more labour, than if the ground were level, and the degree of command the same. But in the second supposition, that will be given in our present article, I propose to explain the full extent of the great disadvantage, which evidently arises from the circumstance of being commanded even upon level ground, which requires the parapet to be made much higher and more substantial, and consequently requires much more labour, than if a battery on such ground were not commanded. Hence it follows, that upon the whole, the formation of a battery on a descending plane, and also exposed to a considerable command, ought to be reprobated, as two circumstances, each in itself highly disadvantageous, are combined in this construction.

*Secondly.—When the Battery is itself situated on level ground, but is considerably commanded by the Fortress.*

If we suppose the Fortress to have an unusually great command over the position of the battery, such as 100 yards for example, which at the distance of 500 yards is equivalent to 4 feet in 20; the interior height of the parapet must be increased to 11 feet, in order to afford the requisite cover of seven feet to the gunners employed near the tail of the platform, who are then placed about 20 feet in rear of the parapet; and in this case, the superior slope of the parapet, instead of being laid out at a dip or depression of one foot in twelve, in reference to the horizon, should be laid out at the same depression, below the line of fire of the guns of the fortress. Hence the top of the parapet of our supposed battery will have a counterslope of about 2 feet, which will make it about 13 feet high in front; and this

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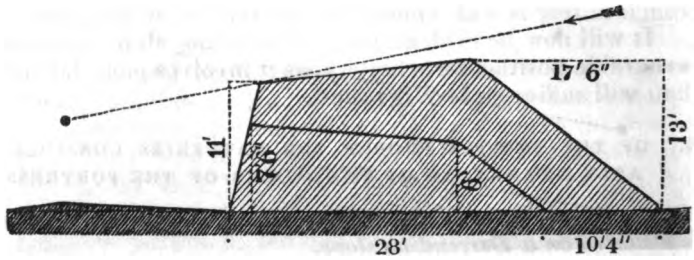
great increase of height will produce a proportional increase, in the extent of ground covered by the base of the parapet.




The foregoing figure exemplifies this construction, being the profile of a battery raised to the extraordinary height, that has been stated, in order to guard against the great command to which it is exposed. The smaller profile, that would suffice for the parapet of a battery not so commanded, is shown by a dotted outline in the same figure. On comparing these two profiles, it will be observed, that the parapet necessary for the commanded battery exceeds that of the common battery in height by 3 feet 6 inches interiorly, by 7 feet exteriorly, and by 10 feet 4 inches in extent of base. Hence it will be found, on calculation, that the former will require more earth than the latter in the proportion of 7 to 3 nearly, and the execution of it will involve labour in a still greater proportion; because the excess of height and of base must necessarily add considerably to the comparative exertion, of throwing the earth to form the larger parapet.

*Thirdly.—When the Battery commanded by the Fortress is situated on an Ascending Slope.*

In this example, we will suppose the battery to be exposed to a command of 1 foot in 5, and that the ascending slope on which it is situated is also in the proportion of 1 foot in 5, having its rise equal to the dip of the guns of the fortress, but in the contrary direction. Hence if the tail of the platform, having the usual rise of 6 inches, be supposed to coincide with the surface of the natural ground; the necessary cover of seven feet will be afforded to the gunners standing there, by giving to the parapet a total interior relief of 10 feet 6 inches, of which 3 feet 6 inches are sunk below the natural surface, as shown in the annexed figure, which is the profile proper for a battery so circumstanced,

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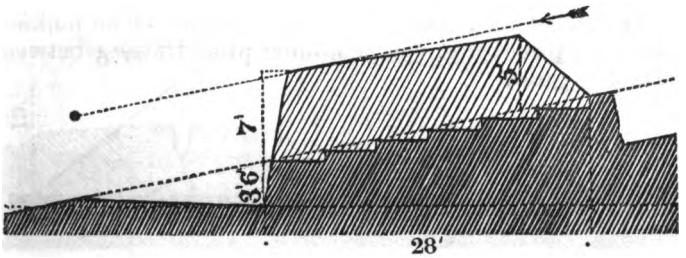
The superior slope becomes a counterslope, as in the foregoing example, by giving to it a dip of 1 foot in 12, in reference to the line of fire of the guns of the fortress.




On inspecting the above figure with attention, it will be seen, that notwithstanding the very great command, to which it is exposed, the ascending slope produces the favourable effect of diminishing the quantity of labour necessary for forming a sufficient parapet: so that in this profile it is not greater, than would be required for the formation of a common elevated battery on level ground, not so commanded.

In gun batteries, exposed to such a very considerable command, as in the two last examples, the sill of the embrasure may be made 4 feet 6 inches high, even for direct firing; and the sole of it may have a considerable counterslope,

### 5. OF INCLINED BATTERIES.

In treating of batteries on sloping ground, we have hitherto supposed the face of the battery to be laid out at right angles to the slope, so that both the extremities of the interior base line of the parapet are on the same level, or nearly so.

An inclined battery differs from the above, inasmuch as the face of the battery is supposed to descend a slope, so that it is higher at one extremity than at the other.

As it is necessary, that the opposite parts of the two sides of a gun platform should every where be on the same level; a battery so situated should be formed in terraces or steps, each being a one gun portion; and therefore some addition must be made to the usual spaces of 18 feet per gun, &c., allowed in determining the length of the face of a common gun battery, on account of the base of a slope, which must be allowed between every two terraces, in proportion to the steepness of the original ground, and to the tenacity of the

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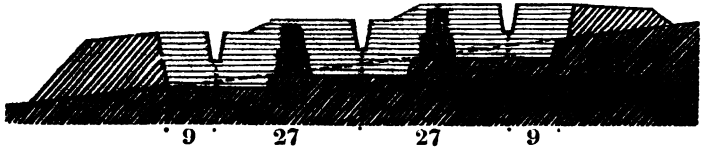
soil. In a mortar battery the same rule must be followed, but without so great an increase per mortar to the length of the face of the battery, because a mortar platform does not occupy so much space as a gun platform.

The following figure is the rear elevation of an inclined battery for three guns, with a splinter proof traverse between every two guns.




In a battery of the above description, one can scarcely allow less than 21 feet for each gun, without the traverse, or 27 feet with the traverse, as shown in the figure; supposing the difference of level, between each terrace or one-gun portion to be only 3 feet. On a steeper slope, a still greater additional space per gun must of course be allowed, in proportion to the nature of the slope. The epaulment on the lower flank of the battery must be laid out at right angles to the parapet, instead of giving it the usual splay of 1 foot in four.

It may perhaps be scarcely necessary to remark, that the number of feet allotted to each gun, in tracing the outline of the battery, must be measured as in surveying, according to the horizontal level, not according to the original slope of the ground.

The above spaces are stated under the supposition, that the battery is not outflanked by the enemy's works on its lower side. If that disadvantageous circumstance should take place, the common splinter proof traverses shown in the above figure will not suffice. Traverses of much greater thickness will be required to screen every one-gun portion, and the length of the face of such a battery, as well as the labour of forming it, will therefore be greatly increased; so much so in the case of a steep slope, and of considerable outflanking, as to operate as an entire prohibition against the construction of such a battery.

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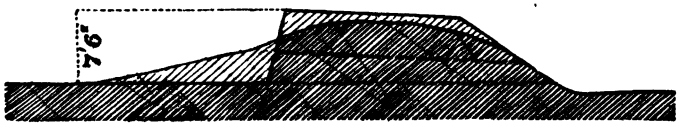
6. OF THE ADVANTAGE, THAT MAY OCCASIONALLY BE TAKEN OF A NATURAL OR ARTIFICIAL BANK, IN THE FORMATION OF A BATTERY.

Sometimes a natural or artificial bank may happen to be so situated, as to agree nearly with the position suitable for the face of a proposed battery; and it is not impossible, but that such a bank may form the greater part of the parapet of a gun battery, by cutting embrasures if necessary through the lower part of it, cutting the reverse of it into the proper form of the interior slope, adding the necessary revetments, and raising the upper part to the proper height and thickness; as represented in the annexed figure, in which the curved outline is the section of a natural bank formed into the parapet of a gun battery by this process.




A bank of the same description as the above, but a little higher, might form a complete parapet for a mortar battery, with little or no additional labour.

7. OF OBLIQUE GUN BATTERIES ON NARROW GROUND. THAT THE PARAPET OF SUCH BATTERIES MUST BE INDENTED. THAT A CHAIN OF SEVERAL TWO GUN BATTERIES MAY SOMETIMES BE USED, INSTEAD OF ONE OBLIQUE GUN BATTERY OF EQUAL FORCE.

In the attack of fortresses, on hilly or on marshy ground, a narrow ridge or a dyke are often the only positions that offer themselves for batteries, which if convenient in other respects, are generally oblique to the face of the work, against which they are required to act.

In this case the interior base line of the parapet of oblique gun batteries must be indented, because the front of the platform, and back of the merlon must necessarily be at right angles to the line of fire, or object line of every embrasure.

The space necessary for each gun should likewise be increased from 18 to 20, 21, or even 22 feet, according to the obliquity, because the indents weaken the revetment, and those spaces must not be set off obliquely, along the

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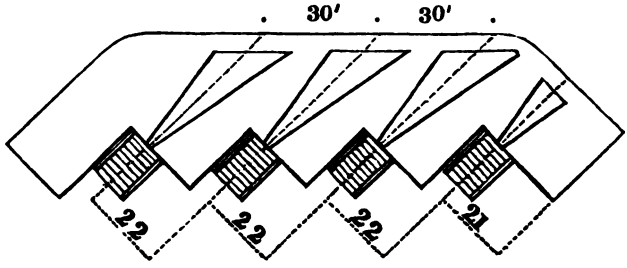
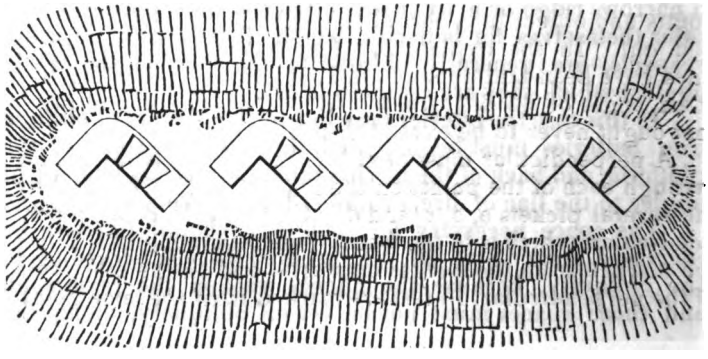
general line of the narrow ground, on which the battery is constructed but perpendicularly, between the several object lines produced. Hence if the angle of obliquity be 45 degrees, it is evident, that the length of each one-gun portion of the battery, if measured obliquely will be nearly 30 feet: although the nett space for working each gun should only be 20 feet in width.

The outside of the parapet of an oblique gun battery need not be indented like the inside; but care must be taken, that the least thickness of the parapet, in the direction exposed to the enemy's fire, shall no where be less than the standard thickness of 18 feet.

The annexed figure represents the outline of a four-gun battery of this description, in which there are four indents,




or angular spaces in rear of the parapet, one side of each of which is called the *Face* of the indent, namely that side in which the embrasure is cut; whilst the other is *the Flank* of the indent, forming a kind of epaulment to each one-gun portion: and indeed the flank of the extreme or most retired one-gun portion becomes, by lengthening it, the epaulment of the battery.



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It is evident, that an oblique gun battery constructed in the manner that has been described, may be considered as a series of one-gun batteries, connected together: and this arrangement is the most proper, when the width of the supposed ridge or dyke is limited: but if it should be so great as to admit of two guns being placed abreast of each other, it will be simpler to construct a series of common two-gun batteries in echellon, as in the following figure, in preference to the arrangement before described.

This last method is not generally a saving of labour, but it simplifies greatly the construction of the battery, for when the obliquity is considerable, the tracing of an indented gun battery is rather a complex operation; so much so, that after having now explained the general principle, it will be proper to devote another article to the details of this construction.

## 8. THE SAME SUBJECT CONTINUED. RULES FOR THE TRACING OF AN OBLIQUE GUN BATTERY.

In tracing an oblique gun battery, on a ridge of narrow ground whether natural or artificial, a line is first drawn about 20 feet in front of the reverse of the ridge, and parallel to it. By this line, which afterwards becomes an imaginary one, the embrasures are to be regulated. *(See the dotted line drawn through the points* a, b, c, *in the next figure).*

A point a, is assumed in the above regulating line for the first embrasure of the battery, from which point previously marked by a picket, an oblique line is traced towards the front, to mark the object line of this embrasure. Parallel to this object line, at the distance of 22 feet, measured of course perpendicularly, a second object line is traced through the point b, a third through the point c; and so on until points and object lines for all the embrasures shall be marked out. In the explanatory figure annexed, the object lines have been laid out so as to intersect the regulating line at an angle of 45 degrees, which is a degree of obliquity, that ought never to be exceeded in practice.

A perpendicular must next be drawn to each object line, through each of the points on the regulating line, marked by the several pickets a, b, c, and d. On that side of each perpendicular, which is to the front of the regulating line, 7 feet are marked from the picket outwards, and on the other side of the perpendicular, 15 feet are marked from the same point.

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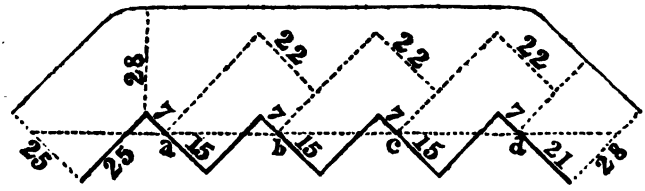
Thus the length of each perpendicular is limited to 22 feet, excepting that on the advanced flank of the battery, which is made 6 feet longer, for the purpose of giving more solidity to the extreme half merlon on that side. The extremity of each perpendicular is then connected, to the nearest and opposite extremity of the perpendicular in front of it. And thus the indented form of the interior base line of the parapet is traced, the perpendiculars being the faces, and the connecting lines the flanks, of the several indents or one-gun portions. In rear of, and at right angles to the face of the extreme one-gun portion on the reverse flank of the battery, a line 25 feet long is traced for the epaulment, which being done, the whole interior base line of the parapet will be completed in the indented form proper for this kind of battery, the outline of which is marked thick in the following figure.

If the battery is to be an elevated one, the exterior berm lines of the parapet and epaulment must next be traced, at the respective distances proper for a common elevated gun battery, namely at the parallel distance of about 28 feet for the former and of 25 feet for the latter. The exterior berm line of the parapet is laid out at the first named distance, parallel to and in front of an imaginary line drawn through the salient angles of all the indents, excepting on the advanced flank of the battery, where it is traced parallel to the face of the extreme one-gun portion. This completes the tracing for the elevated battery as represented in the annexed figure.




The nearer that each embrasure is placed to the salient angle of the indent or one-gun portion to which it belongs, the stronger will the irregular part of the merlon be: but on the other hand, this distance must not be diminished to less than 6½ or 7 feet, the last of which dimensions has been chosen in the above figure, because the space is sufficient to allow the gunners on that side to use their handspikes without constraint. The inconvenience of too small a space

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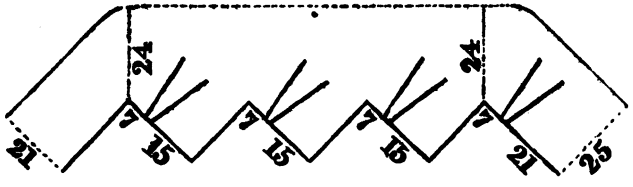
between the gun platforms and the flanks of the indents in which they are situated, will be more evident, if you refer back to the figure in page 234, in which the platforms also are represented, in addition to the outline of the plan of an indented gun battery.

In this kind of battery, the revetment of the indented outline is commenced with fascines, gabions, or sand bags in the usual manner, but the embrasures are not traced, until the solid is completed to the proper height; after which they will be laid out as in a common elevated battery, by means of the pickets a, b, c, and d, which mark the center of each.

Oblique gun batteries being by supposition constructed on narrow ground, it is possible, that there may not always be room for an elevated battery, which requires a piece of ground measuring nearly 70 feet from front to rear, in order to allow sufficient space, not only for working the guns in rear of the parapet, and for the parapet itself, but also for the ditch in front, which is to supply the earth for constructing it. In this case, therefore, the sunken profile must be adopted, for which a space of ground of 50 feet, as measured from front to rear, will afford ample room. The tracing is executed precisely by the same rules as the former, excepting that as soon as the indented outline of the interior of the parapet and epaulment shall be traced, the embrasures must also be traced, in the same manner as in a common sunken battery.

The annexed figure therefore represents the tracing of an oblique sunken gun battery of the same strength as the former.




The exterior berm line of the epaulment must be traced at the usual distance, and continued as far to the front as the ground will permit, because the earth for the epaulment must be obtained from the outside: but as there is no ditch in front of the parapet, the exterior base line of the parapet, which is dotted in the above figure, need not be traced on

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the ground, until some time after the commencement of the work.

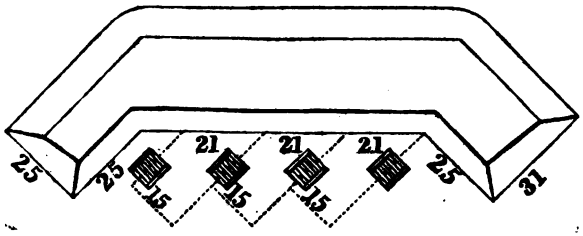
In respect to the embrasures of oblique gun batteries whether elevated or sunken, the splay should not be continued indefinitely to the extreme front of the parapet, but after gaining in width and slope to the distance of about 10 feet, the cheeks of the embrasure may from thence become nearly parallel; and consequently its width and slope uniform or nearly so, with little or no further increase: otherwise the extreme length of the embrasures, caused by the obliquity of their direction, might bring the front of the merlons almost to a point.

9. THAT THE PARAPETS OF OBLIQUE MORTAR BATTERIES NEED NOT BE INDENTED. THAT MORTAR BATTERIES MAY BE CONSTRUCTED IN REAR OF PARALLELS, OR OF OTHER BATTERIES.

*First.—Of Oblique Mortar Batteries.*

On considering the peculiar mode of firing of mortars, it will evidently be unnecessary to indent the parapet of an oblique mortar battery; but the central distance from platform to platform must not be measured obliquely, in reference to the parapet, but perpendicularly in reference to the object lines of adjacent mortars. Hence if the angle of obliquity be nearly 45 degrees, the central distances of the mortar platforms may require to be increased from 15 to 21 feet, if measured along the oblique line of the parapet, for the same reason before explained, in treating of oblique gun batteries: and the platforms themselves should be laid in a direction perpendicular to the several object lines, or proposed lines of fire of each of the mortars, instead of laying them out perpendicular to the parapet.

The annexed figure is the outline of the plan of an oblique battery for four mortars constructed according to the above rule.

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*Secondly.—That Mortar Batteries may sometimes require to be placed in rear of other Batteries.*

Strong reasons may sometimes occur for placing a mortar battery directly in rear of a gun battery, for example, when a very long narrow line of works is to be powerfully enfiladed both by guns and mortars, and the placing of all those pieces of ordnance in the same front might extend them so far to the right and left of the direction of the works attacked, as to throw a part of them out of the most effectual line of enfilade. In this case, if the gun battery be constructed in front of a parallel, the mortar battery may be placed from about 20 yards to 50 yards in rear of it, from even the former of which distances, the shells will pass over the men in the parallel, without annoying them. The same necessity may occur in the attack of a fortress in a hilly country. A height occupied by the besiegers, may afford a favourable position for gun and mortar batteries, against the place, but not for a sufficient number to make a powerful impression upon it, if they should all be placed in one and the same line. In this case, therefore it may be expedient to place them in two lines, namely the gun batteries all in front, and the mortar batteries in the rear.

## 10. THAT RICOCHET BATTERIES MAY FIRE OVER PARALLELS AND OTHER WORKS OF THE BESIEGERS, FROM A CERTAIN DISTANCE, WITHOUT INCONVENIENCE.

It was before stated, that the best elevation for ricochet firing is from 6 to 9 degrees. At 6 degrees, the shot rises at the rate of about 1 foot in 10: hence a ricochet battery may fire over a parallel or other work of the besiegers, from the distance of 50 yards in rear, without any inconvenience to the men posted in it, because the shot will rise 15 feet in that distance, and even when fired from a sunken battery, it will clear the heads of the men in the parallel by about 14 feet, which is sufficient not merely for safety, but for comfort. At a greater distance the annoyance if any will diminish, until the distance shall equal half the range of the projectile. Thus for instance, ricochet batteries placed a little in front of the first parallel, will not annoy troops in the second parallel at all, because every shot will pass over their heads, at the greatest height to which it rises in its flight. When the distance exceeds one-half of the average range, the shot begins to descend, and any considerable increase beyond that limit, will produce annoyance. For this reason, the

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ricochet batteries in front of the first parallel should be disarmed, as soon as the besiegers have pushed their approaches as far as the third parallel, or even a little before they reach that position.

The nature of the projectile, is also to be considered, it being evident, that a ricochet fire of grape or of spherical case shot (Shrapnels' shells) would be more dangerous to the advanced troops of the besiegers, than a ricochet fire of round shot.

### 11. OF CONVERTING PART OF A PARALLEL INTO A MORTAR BATTERY. NUMBER OF WORKMEN NECESSARY.

The only thing necessary to effect this object, will be to cut the trench wider towards the rear, until it attains the extreme width of about 15 feet at the sole, and to throw the earth thus obtained, over the parapet, to increase its thickness; because a common parallel is not shot proof, against heavy guns, and the opening of the mortar battery in it might draw the enemy's fire upon that particular spot.

In converting a parallel into a mortar battery, 7 labourers per mortar may be employed in difficult soil, namely, 4 as diggers in rear of the trench, and 3 as shovellers in front, of whom one may occasionally get upon the parapet to spread the earth.

In easy soil, 4 labourers only will suffice, of whom 2 may be diggers, and 2 shovellers.

As the quantity of excavation required is very little more than 10 cubic yards, the whole work ought to be completed with ease in about 5 hours, by one relief of common military workmen.

In respect to the light brass mortars, (Royals and Cœhorns) the trench of a parallel need not be widened, for receiving them, nor need the thickness of the parapet be increased; because they require very little space for working them, and the few men necessary for that purpose are not much exposed; and these pieces can be carried off in a moment, from one part of the trenches to another.

### 12. THAT THE SPACE ALLOWED TO EACH MORTAR, IN A MORTAR BATTERY, MAY UNDER PECULIAR CIRCUMSTANCES BE DIMINISHED TO LESS THAN THE USUAL INTERVAL OF FIFTEEN FEET.

The space of 15 feet per mortar, allowed in determining the length of a mortar battery, has been so regulated, that

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there is ample room for working the several mortars, and for firing them, independently of each other, without inconvenience to the artillery men.

But if the mortars of a battery be fired alternately or by volleys, instead of independent firing, the smaller space of 12, 10, or even of 9 feet per mortar, will suffice; for even should the last named dimension be adopted, there will be a clear interval of 2 feet 6 inches, between the platforms. This arrangement will of course afford a considerable saving of labour, in the construction of a mortar battery, inasmuch as it will require fewer men, in proportion to the diminution of the length of the parapet.

### 13. OF CONVERTING A PORTION OF PARALLEL INTO A GUN BATTERY.

In converting a portion of parallel into a gun battery, which is a very simple operation, when the proposed line of fire of the guns is perpendicular to the parallel, openings for embrasures must be made in the parapet at the usual interval of 18 feet apart.

In cutting out each of these openings, care must be taken in the first instance, to allow about 4 feet more in width, than the usual dimension proper for the sole of a common embrasure, in order to make room for the gabions, which constitute the best reveting material for the cheeks of embrasures. This additional width of 4 feet need not extend to the extreme front of the embrasure, but only so far as to make room for four or five gabions in each cheek, that is to the distance of about 10 or 12 feet from the interior slope of the parapet.

At the same time, the front step of the parallel, and about half of the berm, must be cut away for the space of about 12 feet, making the front of the excavation vertical.

The revetments of the battery must be made precisely similar to those of a sunken gun battery.

The parapet of a common parallel being too weak, and the trench too narrow for the manœuvres of a heavy gun, the excavation must be increased by cutting away the ground in rear of it, in such a manner, that the trench of the finished battery shall measure 16 feet at the sole from front to rear, and 3 feet deep in front, but only 2 feet 6 inches deep in rear, in order to accommodate the rise of the platform, with a reverse slope of double the last named depth. In consequence of this arrangement, the sole of the original trench of the parallel will have to be raised at a regular slope from the



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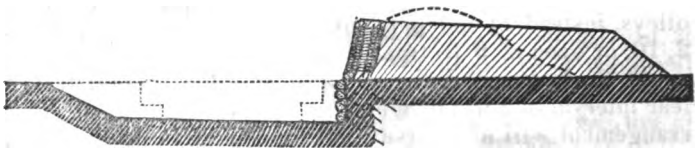
front towards the rear, to the extreme height of nearly 1 foot above its original level.



The annexed figure is the section of a gun battery formed in an unreveted parallel by this rule. It is supposed to be taken through a merlon. The original profile of the parallel is dotted.

14. MATERIALS, NUMBER OF WORKMEN, TOOLS, TIME, AND ARRANGEMENTS, NECESSARY FOR CONVERTING A PORTION OF PARALLEL INTO A GUN BATTERY.

*First.—Quantity of Materials per Gun necessary.*

When the parallel has been commenced by the sap, and consequently is reveted, the materials necessary for each one gun portion will be

| | |
|---|---|
| Gabions for the cheeks of the embrasure | 8 or 10 |
| Fascines | 4 |
| Pickets (of which about one-fourth for tracing) | 25 |
| When the parallel is unreveted, add to the above for the interior slope, gabions | 8 |

*Secondly.—Number of Workmen, Tools, &c.*

| | |
|---|---|
| Workmen | 8 or 9 |
| Pickaxes | 6 or 7 |
| Shovels | 8 |
| Rammers | 2 |
| Tracing line | 1 |
| Six feet rods | 2 |
| Field level | 1 |

*Secondly.—Arrangements and Distribution of the Workmen.*

In easy soil 2 diggers, in difficult soil 3 will be employed at the reverse of the trench, 2 diggers cut out the embrasure, whilst 2 diggers in the front of the trench cut away the front step, and half the berm, to the distance of 6 feet on each side of the center of the embrasure, that is for a space of 12 feet in all, after which, they revet the front of their

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own excavation with four vertical courses of 12 feet fascines. This being done, they will act as shovellers to the diggers, at the reverse of the trench.

If the parallel be unreveted, the remaining 2 men commence by laying a fascine along the front of the original berm, after which, they will place 8 gabions over it at the usual slope of one-fourth, with an opening of two feet in the center, for the neck of the proposed embrasure. They must fill these gabions, and make good the space between them and the crest of the original parapet, with rammed earth, which being done, they will act as shovellers on the parapet. If the parapet itself be reveted, they will only have to pull out one gabion, to make room for the neck of the embrasure, and afterwards they may crown the original gabions with one course of fascines, towards the close of the work. In this case, as there will be little work for them at first, one of them may dig, or act as a shoveller to the diggers in rear, for about an hour, after which, he will find employment on the parapet.

The two men, who cut the embrasure, will place the gabions in the cheeks, as soon as they shall have cleared away a sufficient space for them. In filling them, they will be assisted by the shovellers on the parapet.

*Thirdly.—Time necessary to complete a One-Gun Portion.*

In difficult soil, the men employed in cutting away and reveting the front of the trench, may finish this part of the work in about two hours, and those who are employed in cutting and reveting the cheeks of the embrasure, will finish this part of the work in about three hours. The whole one gun portion of the supposed battery may be completed by nine good workmen in rather less than four hours, in the hardest soil: and therefore it will not be too severe a task for one relief of a common military working party. In easy soil, it may be finished by 8 men in about three hours.

*Fourthly.—Extra Labour necessary for the extreme Half Merlons.*

The above arrangement furnishes earth enough for all the intermediate merlons of a battery of several guns, but not for the two extreme half merlons, which, require to be strengthened, like those of a common gun battery, not having epaulments. For this purpose, each of the extreme half merlons must have its parapet thickened to the distance of 19 feet from the center of the adjacent embrasure, which will increase the length of the battery by 10 feet on each flank, making 20 feet in all, over and above the ordinary allowance of 18 feet per gun.



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In difficult soil, 5 men extra may be employed for each extreme half merlon, of whom 3 men will dig in rear, in a space of about 14 feet, and 2 will act as shovellers.

In easy soil, 4 men only per half merlon, will suffice, of whom 2 will dig in rear, and 2 will act as shovellers.

The additional parapet must be reveted, for which 5 gabions, 1 fascine, and 6 pickets extra may be demanded, for each half merlon.

*Sixthly.—Extra Labour occasioned by each Splinter Proof Traverse.*

The extra thickness of parapet necessary, opposite to the position of the proposed traverse, must be obtained from a ditch cut about 12 feet in front of the foot of the exterior slope of the parallel. Four men may be employed in this part, 2 to be diggers, the other 2 to revet the interior slope of this portion of parapet, and to act as shovellers and rammers. So far this arrangement is similar to that of a common sunken battery.

Eight or 9 workmen more must be employed about the traverse itself, which must be formed of earth obtained from the rear: and the labour of constructing it will not be much less than that of forming a traverse in an elevated battery; because the former is itself in fact an elevated traverse, in reference to the trench of the parallel, in which it is to be constructed.

As the same rules therefore will nearly apply to both, the reader may refer back to Section III., articles 23 and 27, (*Pages* 76, *and* 83) in which the construction of a gabion splinter proof traverse for an elevated battery is explained. The only material difference is, that in the parallel, the excavation to supply earth for the traverse must be commenced, by widening the original trench for the space of ten feet in length, and must be continued to the rear, until the traverse itself, as well as a sufficient passage all round it, shall be completed.

15. THE SAME SUBJECT CONTINUED. THAT EVERY BATTERY CONSTRUCTED IN A PARALLEL SHOULD HAVE A COMMUNICATION IN REAR OF IT. REMARKS ON THE SYSTEM OF CONVERTING PORTIONS OF PARALLELS INTO BATTERIES. THAT IT IS NOT GENERALLY EXPEDIENT.

Whenever a battery is constructed in a parallel, a communication in rear, resembling a portion of the same parallel, must be carried entirely round it, at the distance of about

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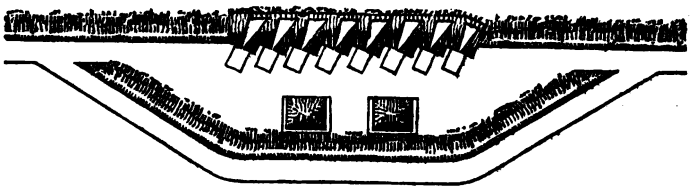
20 yards from the face of the battery, and connecting with the original parallel by a couple of defiladed boyaus. The central part of the communication must be parallel to the face of the battery, and equal to it in length. The annexed figure represents this arrangement in rear of a portion of parallel, supposed to be formed into an eight gun battery.



The distance of 20 yards is supposed to be measured between the interior slope of the battery, and the front of the trench of communication. Less would not suffice, because the spaces required for the service of the guns, and the parapet of the said trench, occupy so much of the above interval, that there is just room for field powder magazines between, two of which are represented in the foregoing figure.

As a battery evidently ought not to be made a thoroughfare, communications of the above description are absolutely necessary, to prevent the passage of infantry along the parallel from being impeded by, or interfering with, the service of the guns.

REMARKS. On giving due consideration to this subject, it will be found, that the formation of a gun battery in a finished parallel, under the very advantageous circumstance supposed in article 13, of having the embrasures laid out at right angles to the parapet of the parallel, will involve rather more labour, including the communication in rear of it, than the construction of a sunken battery in front of the parallel, with a couple of boyaus leading to it. But if the line of fire of the gun battery, proposed to be constructed in a parallel, should be oblique in any considerable degree: the parapet must be indented, according to the rule before laid down, for oblique batteries, on narrow ground, as represented in the foregoing figure, which will so much increase the comparative trouble of forming such a battery, as to render it much more laborious than the formation of a common sunken battery, of equal strength, on the unobstructed ground, in front of the parallel.

The construction of oblique mortar Batteries in a paral-

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lel, also involves much more labour, than that of common sunken mortar batteries, of equal force on the open ground, in front of it; but if the line of fire be perpendicular, or nearly so, the former arrangement is not attended with more labour than the latter. This favourable circumstance, however, can so rarely be expected to occur, either in gun or mortar batteries: that upon the whole, it appears to me, to be generally inexpedient, if not highly objectionable, to place gun and mortar batteries in a parallel; although this system has been strongly recommended by some elementary writers on the Attack of Fortresses.

### 16. OF CUTTING OUT EMBRASURES FOR GUNS IN A SOLID PARAPET, UNDER THE SUPPOSITION THAT THE WORKMEN ARE EXPOSED TO FIRE.*

*First.—Number of Men, and Materials necessary for each Embrasure.*

Four men, namely 2 diggers and 2 shovellers will be required, and 10 gabions must be provided for the cheeks of the embrasure.

*Secondly.—Execution of the Work.*

The two diggers must first pull down one gabion of the original parapet, as an opening for the neck of the proposed embrasure: and one of those men standing in rear of the parapet, must increase this opening by his pickaxe and shovel, until there is room for him to get up and work there, which he must do kneeling in the same manner nearly as in the regular sap; and the second digger must also get up into the same opening, and work kneeling abreast of the former, as soon as there shall be room for him also.

Agreeably to the rule given in article 13 of this section, the excavation must be made 4 feet wider than is necessary for the sole of a finished embrasure, in order to make room for the gabions of the cheeks, which must be placed in successive pairs, in proportion as the excavation advances towards the front. As the digging, or rather sapping in the embrasure, is by far the most laborious part of the work, the diggers must be relieved by the shovellers, after each pair of gabions is placed.

* By this process, several of the embrasures of the breaching battery at St. Sebastian, were cut out in broad daylight, and under fire, by a party of the Royal Sappers and Miners, under Lieutenant, (now Brigade Major) Matson, after the guns in a part of the battery previously finished, had actually opened against the fortress.

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Supposing the original parapet to be of the full height necessary for a gun battery, the first part of the earth obtained from the embrasure must be thrown to the rear, and disposed of by the shovellers, so as not to interfere with the platforms. If it cannot be used to advantage in the interior of the battery, it must be thrown altogether to the rear. As the excavation of the embrasure advances towards the front, part of the earth may be thrown upon the merlons: the remainder of it may be thrown entirely over into the ditch, if the battery be an elevated one: but in a sunken battery care must be taken not to block up the mouth of the embrasure, and therefore what cannot conveniently be thrown upon the merlons must either be thrown to the front of them, or entirely to the rear of the battery.

*Thirdly.—Time required.* In cutting out an embrasure in stiff soil, the first pair of gabions may be placed in about an hour and five minutes after the work is commenced: the next pair may be placed in about 40 minutes more, and the succeeding pairs rather more expeditiously. The whole embrasure may be completed in about four hours.

In easy soil, the first pair of gabions may be placed in about 40 minutes, the second pair in about 35 minutes more, and the whole embrasure may be completed in about three hours.

Hence the cutting out of embrasures in this manner does not require more than one relief of workmen.

### 17. OF CUTTING OUT EMBRASURES FOR GUNS IN A SOLID PARAPET, WHEN THE WORKMEN ARE NOT EXPOSED TO FIRE.

In this case also, four men per embrasure may be employed, as in the preceding article, 2 of whom may dig, and 2 may act as rammers and shovellers. Working in a less constrained attitude, they will of course finish the work sooner, than can be expected of men kneeling. Hence the cutting out of embrasures will be a very easy task for one relief of workmen, when not exposed to fire, even in the most difficult soil.

REMARKS. We have hitherto supposed, that the original solid parapet was of the extreme standard height of 7 feet 6 inches usually given to gun batteries, and accordingly that the greater part of the earth obtained from the embrasure was to be got rid of altogether. If on the contrary, the original parapet should have been only 6 feet high in rear, all the earth obtained from the embrasures should be thrown

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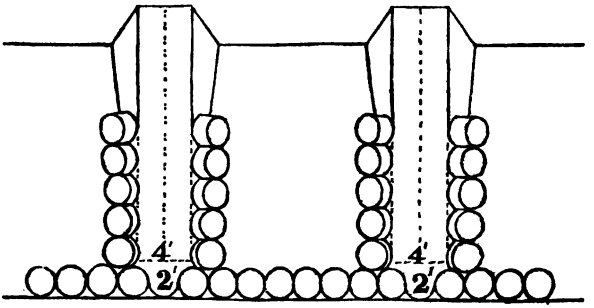
upon the merlons, and will not raise them more than an inch or two above the usual standard height of a finished gun battery.

### 18. OF EMBRASURES MADE WIDER AT THE NECK THAN USUAL, TO PREVENT THE CHEEK REVETMENTS FROM BEING INJURED, BY FIRING WITH FULL CHARGES FROM HEAVY GUNS.

Whilst the experiments to ascertain how far the use of raw hides would protect the gabions of the cheek-revetments of embrasures, from being ruined by the firing of their own guns, were in progress; another expedient was suggested to save the necessity of using hides at all.*

This consisted in placing the two gabions at the neck of each embrasure only 2 feet apart as usual, but in placing the two gabions immediately in front of these, as well as all the other opposite pairs of gabions, at the parallel distance of 4 feet apart at the base. Thus the sole of the embrasure was made 2 feet wide between the neck-gabions, but every where else 4 feet wide throughout, the several pairs of gabions being however placed at a gradually increasing slope from the rear, where they stand nearly upright, to the front, where they partly lie upon their sides, in the manner before explained in section II, article 1, pages 29 and 30. Hence the whole of the gabions in each cheek of the embrasure are not laid in a straight line at bottom, but with a kind of recess, in the manner shown in the annexed figure, which represents this arrangement as applied to two embrasures of a battery.




This expedient proved successful on trial, as the greater width between the gabions immediately in front of the neck

* By Brigade Major Matson, then Adjutant of the Corps.

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of the embrasure, which are most exposed to injury from the above cause, allowed sufficient space for the explosion to vent its force without destroying those gabions.

If this system should be adopted for a battery of heavy guns firing with full charges, for which alone it could be necessary, as the moderate charges used in ricochet firing are comparatively harmless; it might perhaps be desirable to increase the interval per gun from 18 to 19 or 20 feet, because the merlons are a little weakened by the greater width immediately in front of the neck of the embrasure.

### 19. OF CONVERTING THE LODGMENTS ON THE GLACIS INTO BREACHING BATTERIES.

The lodgments on the glacis, being commenced by the sap, and being finished in the form suitable for a parallel; the upper part will be reveted with gabions, whilst the lower part may be left with steps. At this time, the guns of the fortress will have been silenced, and the musquetry of the besieged either entirely kept down, or very much checked by a close fire of sharp shooters, in the trenches. The operation of converting these lodgments into breaching or counter-batteries, may therefore be precisely the same as that of forming gun batteries in a reveted parallel, as described in articles 13 and 14 of this section, and will require the same number of workmen per gun, namely 8 in easy and 9 in difficult soil.

If however, the enemy's fire should be not so completely silenced as before supposed, it may be necessary for the two men, who cut out the embrasure, to work kneeling, as directed in article 16 of this section; and no shovellers can be employed on the parapet. Hence fewer men per gun might be employed in this case, but as one cannot always foresee beforehand, how far the fire of the besieged may or may not annoy the workmen, it will be best in all cases to demand the full number of 8 or 9 men, for at this interesting period of the siege, useful employment will always be found for the spare men.

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# SECTION XIV.

## OF THE NEW ARRANGEMENT FOR SIEGE MORTAR PLATFORMS, ADOPTED SUBSEQUENTLY TO THE PRINTING OF SECTION IX, IN PREFERENCE TO THE METHOD DESCRIBED IN ARTICLES 3 AND 4 OF THAT SECTION, WHICH WILL BE CONSIDERED CANCELLED.

### 1. DESCRIPTION OF THE EXPERIMENTS WHICH LED TO THIS CHANGE.

When section IX was printed, there had been no opportunity of trying the siege mortar platform therein described, but I had applied to the Board of Ordnance for the means of proving its strength by actual firing, before this book should be circulated in the Corps; and having accordingly been supplied with mortars, shells and ammunition for this purpose, the following experiments were tried, in which we were assisted by a party, either of the Royal Artillery, or of the Royal Marine Artillery, who conducted the firing.

Our first trial was by firing a 10 inch mortar, which with its iron bed, weighed 38½ cwt. nearly, with an elevation of 45°, from the platform described in section IX, articles 3 and 4, pages 171 and 172, using only five sleepers instead of six. This platform was laid on alluvial soil on the bank of the Medway, as we could not from any other situation, obtain a range long enough to suit our purpose. In the first four rounds we used 2 lbs. 10 oz., in the remainder of our firing, 3 lbs. of powder. The recoil never exceeded 6 inches, the average recoil being 2 inches, but in some cases no perceptible recoil took place. After a few rounds, the platform betrayed symptoms of weakness, and at the end of forty rounds, most of the planks were split or injured, and two of them broken. On undoing the racklashings and removing the ribbands and planks, we found that the center sleeper and those on each side of it had been pressed down by the shock of the recoil deeper into the mud than the two exterior sleepers, in the position of which no change had taken place; and thus an unequal and injurious strain upon the planks had been produced. The center sleeper in particular had sunk no less than ¾ of an inch in front, and 2⅝ inches in rear.

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On carefully examining the sleepers themselves, we found that they had not been in any way injured or even bent by the shock, which had thus altered their position. It therefore occurred, that by introducing a couple of transverse sleepers under the longitudinal ones, the sinkage which in such very soft soil appeared inevitable, might be rendered equal throughout the whole surface of the platform.*

Accordingly we afterwards fitted up a platform of the same description in the same soil, but with the addition of 2 transverse sleepers under the others, and after firing 4 rounds with 3 lbs, and 26 rounds with 3½ lbs of powder, making 30 rounds in all, the platform remained firm and sound, and did not show a deflection of more than ⅛ of an inch in the center of any of the planks, but the whole had sunk a little more in rear than in front.

When we first fired from the same mortar on the same spot, there was very little recoil, because the flexibility of the platform allowed the shock of the mortar to act chiefly downwards, violently deranging the position of the parts as before described. This day, the recoil was much greater, being no less than 12 inches on an average, the least recoil being 10 inches and the greatest in one instance being nearly 19 inches.

Afterwards on trying the same mortar upon the same platform, but without the transverse sleepers, on sandy soil, originally firm and sound, but which had been disturbed by our field works, we found after a few rounds, that even in this more favourable soil the center sleepers were forced down more than the others, and that the platform was about to be injured. We therefore took it up, and on laying the two transverse sleepers, the result was again satisfactory.

We next tried a 13 inch mortar, weighing about 36¼ cwt, upon an iron bed weighing about 54¼ cwt, making a total weight of 90½ cwt, upon the same platform, laid as before with 2 transverse and 5 longitudinal sleepers, upon the same sandy soil, from which we fired 15 rounds at 45° of elevation, with charges of 5 lbs. of powder. In this experiment the planks were perfectly firm, and uninjured, but the whole platform sank a little more in rear than in front, which we found afterwards was owing to the front of it having been laid upon firm soil, whilst the rear had been laid over the site of one of our old trenches in which the earth was much looser. The average recoil of the mortar was rather more than 6 inches.

* This experiment was tried on the 7th of June, the next on the 21st of June, 1831.

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We next tried the same 13 inch mortar on very soft alluvial soil on the bank of the Medway, in which a small rod might be pushed down with ease to any depth, as the spot was always covered at spring tides. On firing 15 rounds with a charge of 6 lbs, the platform which was again laid with 2 transverse and 5 longitudinal sleepers, sank bodily about 2 inches, but the planks were not injured. The average recoil of the mortar was only 9 inches. In taking up the platform, we found that a curious circumstance had occurred, the sleepers in that soft soil having recoiled from 1 to $5\frac{1}{2}$ inches. The center sleeper had sunk nearly half an inch more than the others, and the whole platform had sunk about half an inch more in rear than in front. Whilst the platform was sinking in the manner that has been described, the mud was forced in between the top of the sleepers and the hind planks, in such a manner as to derange the position of the latter, which being inconvenient we determined not to fill in the intervals between the longitudinal sleepers in future.*

We then removed the same platform to a lower spot of the same alluvial soil, more exposed to the action of the tides. In all our former experiments, we had laid the whole of the sleepers beneath the natural surface, but in this case we laid the transverse sleepers on the grass, and the others over them, and filled the intervals between the transverse sleepers, and the space round the platform with sods and soil, and instead of common pickets we drove strong stakes about 3 inches thick and 5 feet long behind the sleepers, to prevent them from recoiling. In this experiment we fired 15 rounds with a charge of 6 lbs. of powder, and the planks remained firm and uninjured; but the grass, not being of a sound quality, did not offer that resistance which we had expected to the sinkage of the platform, which in this case sank about $1\frac{1}{4}$ inch in front, and about $8\frac{3}{4}$ inches in rear, making an average sinkage of 2 inches in all. The whole platform recoiled nearly 3 inches, in spite of the strong stakes driven in behind the sleepers.

The recoil of the mortar in this case was inconveniently great at first, owing to the soft mud in which the men were working, and with which the platform soon became smeared, and which acted exactly like grease. To prevent this inconvenience, we sent for ashes which deadened the recoil, and reduced it to an average of about 14 inches.†

* This experiment was tried on the 28th of November, the next on the 10th of December, 1831.

† The recoil of mortars is rather capricious. It is small when the mortar bed moves upon a rough dry surface, and great on a smooth wet surface.

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The officers and men who witnessed these experiments are of opinion, that 3 inch fir planks are strong enough for the platform even of a 13 inch mortar, and that for any of the lesser mortars, they possess even superfluous strength. The only reason, that seems to render hard wood preferable, is the great wear and tear of fir plank, caused by the handspikes in moving so great a weight as a 13 inch mortar. In consequence of this injurious action upon fir, it might therefore be proper either to use 3 inch planks of some hard wood in preference, or to increase the thickness of the fir, if used, from 3 to 3½ or 4 inches, in order to make allowance for the wear of the planks during the course of a siege.

In mortar platforms in particular, during the course of those experiments, we became convinced, that wide planks were preferable to narrow ones, and therefore instead of using ten planks, we determined to use eight only for the whole platform, the width of each of which is therefore a hair's breadth less than 11¼ inches.

2. DESCRIPTION OF THE IMPROVED NEW SIEGE MORTAR PLATFORM, ADOPTED IN PREFERENCE TO THAT DESCRIBED IN SECTION IX, ARTICLE 3, WHICH IS CANCELLED.

*First.—General Dimensions of the Platform.*

Seven feet 6 inches long and 6 feet 6 inches wide, which is reduced by the use of ribbands to the clear width of about 5 feet 10 inches only.

*Secondly.—The Sleepers.*

Seven feet 6 inches long, and 6 inches square. The arrises must be taken off, and the ends chamfered, and they must be tarred.

*Thirdly.—The Planks.*

Six feet 6 inches long, to be notched for about 7 inches from both ends, but on one side only, to be bolted or hooped to prevent splitting, and to have the center marked, exactly in the same manner as the gun platform planks described in Section VI, Article 5, page 134. If of fir, each plank must be 11¼ inches wide nearly, and 4 inches thick.

If Oak or any other hard wood be used, the planks may be only 3 inches thick, and their width may be only 9 inches, as it is more difficult to procure wide planks of the harder woods than of fir.

*Fourthly.—The Ribbands.*

To be of fir, 7 feet 6 inches long, and 4 inches square.

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*Fifthly.—Detail and Weight of the above Platform, if covered with Oak Planks.** LBS.

| | |
|---|---|
| 7 sleepers, 7½ feet long and 6 inches square, at 61 lbs | 427 |
| 10 planks 6½ feet long 9 inches in average width and 3 inches thick, at 61 lbs | 610 |
| 2 ribbands 7½ feet long and 4 inches square, at 33 lbs | 66 |
| 10 racksticks 15 inches long, with racklashings 8 feet long, at 1½ lb | 15 |
| Total 9 cwt. 3 qrs. 26 lbs, or lbs. | 1118 |

*Sixthly.—Detail and Weight of the above Platform, if made entirely of fir.* LBS.

| | |
|---|---|
| 7 sleepers 7½ feet long and 6 inches square, at 61 lbs | 427 |
| 8 planks 6½ feet long, 11½ inches wide and 4 inches thick, at 69 lbs | 552 |
| 2 ribbands 7 feet 6 inches long, and 4 inches square, at 33 lbs | 66 |
| 8 racksticks and lashings at 1½ lb | 12 |
| Total 9cwt. 2qrs. 3lbs, or lbs. | 1057 |

*Seventhly.—Number of Men necessary for carrying the above Platform.*

Allowing 1 man for each sleeper, plank and ribband, 17 men may carry the whole platform, whilst a Non-commissioned Officer may carry the racksticks.

3. ESTIMATE OF MEN, MATERIALS AND TOOLS, FOR LAYING A SIEGE MORTAR PLATFORM OF THE ABOVE PATTERN. EXECUTION OF THE WORK AND TIME. BEST MODE OF TAKING PLATFORMS TO PIECES.

*First.—Estimate of Men, Tools and Implements.*

| | |
|---|---|
| 4 men | 1 six feet rod |
| 4 pickaxes | 1 maul |
| 4 shovels | 7 strong pickets 3 inches thick 5 feet long |
| 1 field level | 10 common pickets |
| 1 rammer | |

1 broom for several platforms.

1 handspike for raising the sleepers again, when platforms are laid for practice.

* The oak being estimated at 50 lbs. and the fir at 34 lbs. to the cubic foot.

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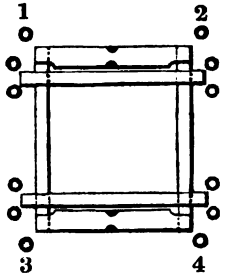
*Secondly.—Execution of the Work.*

The men must be strictly cautioned beforehand, not to cut or injure the sleepers by their tools.

A rectangular space about 8 feet long and 7 feet wide must be marked by pickets for the position of the platform, the center of which space must agree with the center of the sole of the trench, of the one mortar portion of the sunken battery, to which the platform is to belong. The longer side of the rectangle must be regulated by the line of fire, and will generally be perpendicular to the parapet, excepting when mortars placed in a parallel are intended to fire obliquely.

The quickest mode of tracing the rectangle for the mortar platforms, is to lay down two of the platform sleepers with two of the planks over them, so that all those four pieces shall be flush at the extreme ends, forming a regular rectangle, in the manner represented in the annexed figure. This marks the precise space that will be occupied by the finished platform. Four pickets 1, 2, 3, 4, must be driven a few inches further on to each side, so as to embrace the larger space of about 8 by 7 feet as before specified.




Two transverse sleepers are then laid over the longitudinal ones near each end, immediately within the planks and close to them; and opposite to the ends of these sleepers, four pairs of pickets are driven, as shown in the figure.

The sleepers and planks are then removed, and the space between the first four pickets marked 1, 2, 3 and 4, in the annexed figure, must be entirely cleared of earth to the depth of about 6 inches. This being done, two parallel grooves, 6 inches deeper and about 9 inches wide, are cut across the whole width of this excavation, extending so much further at each end as to meet the four pairs of pickets, which are just beyond the sides of the original excavation.

In these small grooves, the two transverse sleepers must first be laid, at the parallel distance of about 4½ feet apart, and carefully levelled, so that each sleeper shall itself be perfectly horizontal, and also on the same horizontal level with the other. This is done by levelling one sleeper first, and then regulating the other, by applying the level between the opposite ends of the two. Five sleepers are then laid longitudinally over these, with their ends projecting equally

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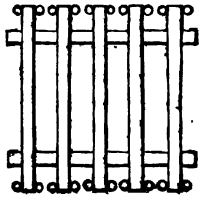
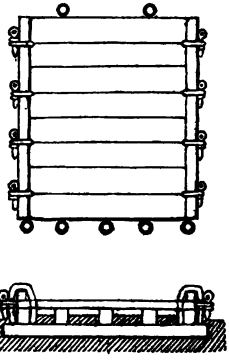
beyond the former, the width apart of the extreme sleepers of these five, being regulated by the length of the platform planks, two of which are laid over them as gauges, and which by the marks on their center determine also the position of the center sleeper.

Ten small pickets are then driven near to the ends of the five longitudinal sleepers, to prevent them from moving laterally, as shown in the annexed figure, which is the plan of the skeleton platform without the planks and ribbands.



Before the two outside sleepers are finally arranged, the racklashings 4 or 5 in number must be introduced under each of them, with the sticks outwards, the extreme racklashings being laid about 11 or 9 inches from the ends of the sleepers. The intervals between the five longitudinal sleepers may then be partially filled, by about 2 or 3 inches of rammed earth, not more, as there are strong reasons, before explained, against raising the earth to the level of the top of the sleepers.

The planks must next be laid transversely over the longitudinal sleepers, and the ribbands longitudinally across the extreme ends of the planks, after which the sides are racked down, by racklashings fixed between the ends of every two planks, the first and last racklashings being placed between the two extreme planks on each side. The platform will then appear in plan as in the annexed figure, in which the planks are supposed to be of fir.



Five stakes or very large pickets must now be driven in rear of the five sleepers, with their heads projecting nearly as high as the top of the hind planks, in order to prevent the whole platform from recoiling backwards, during the firing. A couple of such stakes will suffice in front, where there is little action, excepting whilst the gunners are running up the mortar with their handspikes.

The second figure annexed is the section of the finished platform.

*Thirdly.—Time required for laying the Platform.*

Expert men, who have practised this operation repeatedly, can lay a mortar platform of the above description in

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the stiffest soil, in rather less than an hour, and can completely dismantle it in three minutes.

*Fourthly.—Best method of taking a Platform to pieces.* After undoing the racklashings, which may require the earth on each side to be cleared away, so that the sticks can turn freely round, the ribbands and planks are removed, and piled in good order on one side. The extreme sleepers are then pulled up by the racklashings nearest to one end. Each of the remaining sleepers is raised, by clearing away a little earth, and introducing a handspike under one end of it, and thereby forcing up that end of the sleeper, by which means the wood is not liable to injury.

This method of taking up platform sleepers did not occur, until we tried our platforms by firing from them, which put handspikes into the way of the men. It is so much better than any other method, that we have adopted it for the future, as the rule to be followed, in taking up the platforms laid for practice at this establishment.

### 4. OF THE PROPRIETY OF LAYING MORTAR PLATFORMS WITH A SLOPE IN SOFT SOIL.

Our experiments in firing with a 10 inch and afterwards with a 13 inch mortar in soft alluvial soil, as recorded in article 1, of this section, having proved that the recoil of a mortar in such soil has a tendency to sink the rear more than the front of the platform, it appears to me that in such soil, it would be better to give the platform a moderate rise towards the rear of about 2 or 3 inches in its whole length, which might be arranged by laying the two transverse sleepers, at that slope. This is done by first laying the front sleeper horizontal by the field level, but with the front side of the top of it, a little lower than the rear side. Then the second or hindermost transverse sleeper must be laid parallel to it, at the clear interval of $4\frac{1}{2}$ feet as before stated, and a platform plank used as a straight edge must be applied over the opposite ends of the two sleepers, with the field level over the plank, and the top of the other sleeper may be moved a little, if necessary until the straight edge shall exactly coincide with the upper surface of both these sleepers, whilst the plummet stands over the mark 1 in 45. This allows 2 inches of rise in the whole length of the platform. If you prefer 3 inches of rise in that length, let the sleepers be so regulated that



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the plummet shall stand over the division 1 in 30.

The system now recommended of giving a small rise in rear to a mortar platform in soft soil is not altogether new, having been usual in the French service in the time of Louis the Fourteenth, for every kind of soil. (See Vauban's *Attaque des Places, Chap.* XI.)

## SECTION XV.

### OF THE VARIETIES IN THE CONSTRUCTION OF GUN PLATFORMS, THAT HAVE BEEN SUGGESTED.

#### 1. REMARKS ON PLATFORMS HAVING THEIR PARTS CONNECTED BY SPIKES OR SCREWS.

*First.—Of Spiked Platforms.*

It was before mentioned, in treating of the gun platforms of the new pattern, recently adopted at this establishment, that the spiked platforms formerly used are not suitable for field service. See section VI, article 3, page 131. They are only adapted for permanent purposes, as for the regular practice of guns and mortars at artillery stations.

In preparing to lay spiked platforms, in addition to the common tools and implements as described in section VI, article 6, spike bits calculated to produce holes 3-eighths of an inch in diameter, would be required to bore entirely through the planks, which might be done at the Engineers' Depôt, previously to sending them down to the battery. This boring ought to be very accurately done, in order that after the sleepers are laid, and the planks placed over them, none of the holes should fall nearer than within 2 inches of the side of any sleeper, and thereby render it liable to split, in the driving of the spikes.

It is best to bore a little way into the sleepers also, but in laying platforms before an enemy, it would occupy too much time to go the full depth.

The spikes when driven home should pass entirely through the platform planks, and enter at least 3 inches into the sleepers. Consequently they should be 5 inches

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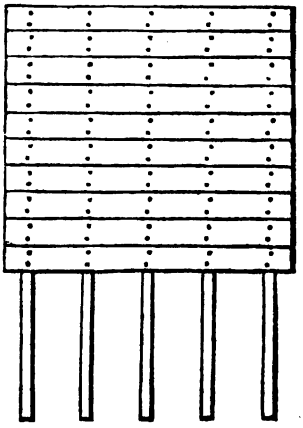
long for gun platforms, and 6 or 7 inches long for mortar platforms, and they should be rose headed, and chisel pointed, as shown in the annexed figure. The broad part of the chisel point, must be made to enter the sleeper transversely so as to cut through as many fibres of the wood as possible. If it should enter the contrary way, or as a wedge in the longitudinal direction of the fibres of the wood, it may split the sleeper. Hence not only the boring of the holes, but even the entering of the spikes afterwards in these holes is a carpenters' operation; whereas the laying of the new pattern gun platform may be done by labourers.

The driving of the spikes of a platform, which is done by the iron tool called a pinmaul, causes much noise, and unless a great number of men be employed about it simultaneously, it occupies a considerable time, and may attract the enemy's fire. This is one objection; but the great difficulty of repair of the spiked platform, if damaged, and the total destruction of it, if attempted to be taken to pieces, are still more urgent reasons against the use of such platforms.

The annexed figure represents a spiked gun platform in progress, which may be supposed to be intended for permanent purposes, and therefore I have shown two spikes per plank to each sleeper, as the parts of permanent platforms cannot be too firmly connected.



If it were intended for a field platform, which as I again repeat is not to be recommended, one spike per plank might be used for the three intermediate sleepers: but double spikes would be desirable for the two extreme sleepers.

*Secondly.—Of Screwed Platforms.*

The use of screws instead of spikes for fixing the planks to the sleepers of a platform requires a much longer time, but it is free from all the other objections, that attach to the spiked platform; as there is no noise in fixing the screws,



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and if well greased at the time, they may be drawn afterwards, without injury to the parts of the platform, which may therefore be used again in a new position.* The screws should pass entirely through the planks and at least 3 inches into the sleepers. Hence 5 inch screws would answer both for gun and mortar platforms, unless the latter be covered with 4 inch fir planks, in which case you must either use 6 inch screws, or let the heads of your 5 inch screws about an inch deep into the planks.

Spike bits of two different sizes must be used for preparing the holes for the screws. The larger of the two must be suited to the size of the upper or smooth part, or as it is technically termed the body of the screw. The smaller bit must be suited to what the diameter of the lower part of the screw would be, if entirely stripped of its threads or spiral projections. The larger bit is used for boring entirely through the platform planks, and also partly into the sleepers, if the body of the screw should be longer than the thickness of the planks. The smaller bit is used in the same hole, previously formed by the larger one, which it deepens so much as may be necessary, for receiving the spiral part of the screw. The holes through all the planks may be bored at the Engineers' Depôt, but the continuation of the same holes formed by boring into the sleepers with the smaller bit, must necessarily be done in the battery itself, after the sleepers are laid in the ground and the planks placed over them.

The screws must be pushed or gently driven through the holes in the planks, until their points just enter the smaller holes in the sleeper below, after which they must be turned by a lever headed screw driver, until they enter the whole depth necessary. The heads of the screws must be countersunk, so as to make them flush with the upper surface of the plank. The threads of the screws whilst being turned, force their way into the fibres of the wood, and compress the intermediate parts.

The sizes of the two bits must be, as before observed, suited to the diameters of the upper and lower parts of the screws, which if well proportioned for the purpose in question, would require a 3-eighth inch spike bit, and a quarter inch spike bit, for each screw hole.

* See Colonel Jones's Journals of the Sieges in Spain, 1st edition, note 16.

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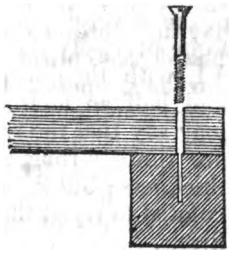

The annexed figure represents part of a platform plank resting on a sleeper, both of them bored in readiness for receiving the screw, which is shown immediately above them. In taking a platform of this description to pieces to use it again in an advanced position, which is done by drawing all the screws by the same kind of screw driver, the holes in the planks will all answer; but those in the sleepers cannot be expected to fit the former again. It will therefore be proper in using the same sleepers, to turn them on a different side, or upside down, in laying them a second time.

In respect to number and position, screws would be used in the same manner as spikes precisely, so that the figure given in the preceding article may apply to the plan of a screwed platform also.

2. OF THE MOST CONVENIENT WIDTH OF PLATFORM PLANKS. THAT IT NEED NOT BE UNIFORM. DETAIL AND WEIGHT OF A SIEGE GUN PLATFORM OF THE NEW PATTERN, HAVING ITS PLANKS WIDER AND A LITTLE STRONGER THAN THOSE BEFORE DESCRIBED.

In treating of gun platforms of the new pattern, in section VI, articles 5 and 6, from page 133 to 140, I suggested the use of planks only 9 inches wide, chiefly from a supposition that there might be a difficulty in procuring wider. Our subsequent firing to prove the strength of our platforms having convinced us, that the fewer joints the better, provided the timber be sound, I beg now to recommend in preference, that the new pattern siege gun platform should be fitted up with 15 planks of the average width of 12 inches, instead of a greater number of narrower ones. These may always be prepared out of the large timber imported from the north of Europe, which usually averages 13 or 14 inches square.

In recommending this dimension for gun platforms prepared before hand in England, it may be remarked that in case of emergency, planks of unequal width may be used for gun platforms, care only being taken, that they shall all be parallel sided and of uniform thickness, and so arranged at the Engineers' Depôt, that the number calculated to suit the length of the sleepers shall be placed together.

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By way of variety I shall annex the detail and weights of the several parts of the siege gun platform, supposing it to be precisely the same as that before described in section VI, with the exception of the planks being 3 inches wider, and half an inch thicker. In regard to this last point, I may say that the two inch planks of the former construction are quite strong enough, so long as they retain their full thickness; but 2½ inch planks will of course be better calculated to resist the wear and tear of the wheels, in continued firing.

*Secondly.—Detail and Weight of a Siege Gun platform of the new Pattern, having its planks a little wider and thicker than those before described.*

| | LBS. |
|---|---|
| 5 sleepers, 15 feet long and 5 inches square, at 101 lbs. | 505 |
| 15 planks 10½ feet long, 12 inches in average width, and 2½ inches thick, at 74 lbs. | 1110 |
| 2 ribbands, 15 feet long, and 4 inches square, at 65 lbs. | 130 |
| 10 rack sticks and lashings, at 1½ lbs. | 15 |
| Total 15cwt. 2qrs. 24lbs, or lbs. | 1760 |

*Thirdly.—Number of Men Necessary for carrying the above Platform.*

Allowing two men for each sleeper, and 1 man for each plank and ribband, 27 men will carry the whole platform, whilst a non-commissioned officer may carry the racksticks. As this is a smaller number of men, than were allowed for the former gun platform, described in section VI, although lighter than the present one, it is proper to explain, that this is occasioned by using fewer planks; for one man may carry one heavy plank of the present platform, but he could not conveniently carry two lighter planks of the former one.

### 3. THAT SHORTER SIEGE GUN PLATFORMS THAN THOSE BEFORE DESCRIBED MAY BE USED.

A platform of the usual width of 10½ feet, but having its length reduced from 15 to 12 feet, which implies shorter sleepers and ribbands and fewer planks, would make an efficient platform for a 24 pounder gun, although not quite so convenient as the longer platform before described.

In both of these platforms, the trail of the travelling gun carriage runs entirely off during a part of the recoil, but even in the shortest of the two, the wheels do not run quite back to the rear of the platform.

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It was before stated (page 135) that the 15 feet gun platform covered with 2 inch fir planks weighs nearly 13¾ cwt. By reducing 3 feet of the length of the above, the 12 feet platform similar in other respects will weigh only 11 cwt.

If 2½ inch fir planks be used, the 15 feet gun platform, described in the preceding article of this section, will weigh nearly 15¾ cwt. A 12 feet platform similar to it in other respects will only weigh about 12½ cwt.

### 4. THAT NO PARTICULAR PRECAUTIONS ARE NECESSARY FOR LAYING GUN PLATFORMS IN SOFT SOIL.

After the experiments recorded in the first part of this section, in which we found that mortar platforms were soon deranged and liable to become unserviceable in soft soil, unless secured by the addition of transverse sleepers, under the common sleepers; it seemed probable, that the platforms of heavy guns might also become deranged under the like circumstances. Accordingly we laid the new siege platform described in section VI, articles 5 and 6, on the same alluvial soil covered by the Medway at spring tides, where the common mortar platform before had failed; but on firing fifteen rounds from it, with full charges of 8 lbs of powder from a 9½ feet 24 pounder iron gun weighing nearly 48¼ cwt., on a travelling carriage weighing 22½ cwt., the total weight of gun and carriage being about 70¾ cwt., no unfavourable effect or derangement whatever took place; nor had the platform even sunk deeper in the mud in any perceptible degree. Hence we became satisfied, that the common mode of laying gun platforms upon five longitudinal sleepers is suitable for soil of every description, and that no particular precautions are necessary in soft soil, that might be dispensed with in other soils.

### 5. GENERAL DESCRIPTION OF THE FIELD TRAVERSING GUN PLATFORM, OR MADRAS PLATFORM.

This platform which is also commonly known by the name of the Madras platform, from its having been first introduced at that Presidency in India,* is fixed by two or

* In all probability, the idea of this platform must have suggested itself after the capture of Pondicherry, where the East India Company's Officers must have seen the French *Affûts de Place*, or garrison gun carriages having platforms attached to them, to which the field traversing platform is similar in principle.

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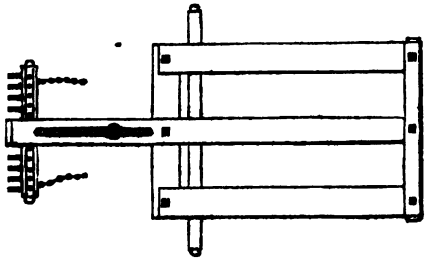
three pivots in front, but is capable of traversing in rear. It consists of a rectangular frame, of which the principal parts are two strong side pieces or longitudinal planks for the wheels, and one central piece parallel to them, for the trail of the gun carriage to move upon.

The annexed figure is an exact copy of the plan of the platform, used in the practice of the Madras Artillery at their depôt at St. Thomas's Mount, near Madras.* There is one transom bolted to the side pieces, in rear, and two in front, one above and one below, both connected by the same bolts. The uppermost of these last serves as a hurter, whilst the undermost, of which the extreme ends only appear in the plan, acts also as a sleeper. One sleeper supports the side pieces towards the rear, and a second sleeper supports the trail piece, which projects considerably behind the former, and which is grooved in the manner shown in the figure, for an iron pintail to move in, which passing also through the hole in the trail of the travelling carriage, confines the trail in its proper position during the recoil of the gun.



In this drawing and in all other descriptions or models of the Madras platform that I have seen, the hind sleeper has iron pins projecting from it in a horizontal direction, and it has also an iron plate at top, with a great number of small pin holes cut in it. The former are for the hand spikes to bear against, in traversing the platform, the latter for fixing the trail piece or the side pieces, so as to preserve the platform in a particular direction when required.

### 6. EXPERIMENTS WITH THE FIRST FIELD TRAVERSING PLATFORM, CONSTRUCTED AT THIS ESTABLISHMENT.

We made our first field traversing platform with three long parallel pieces, two for the wheels, and one for the trail, with a fore transom acting also as a sleeper, and a hind tran-

* As contained in a lithographed book of rules for the practice of the Madras Artillery, drawn up by Lieut. Col. Frith, Director of the Practical Instruction of that corps, which he obligingly presented to me some years ago. From its apparent proportions, I apprehend that the platform represented in the figure must have been used for lighter guns than 24 pounders.

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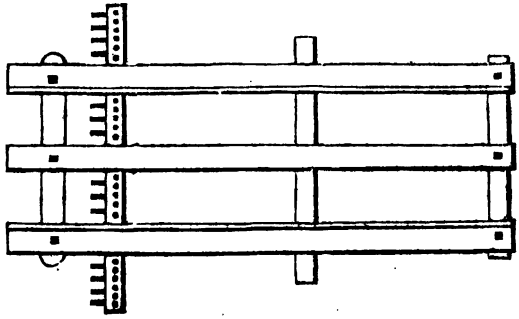
som, each bolted to the longitudinal pieces, as shown in the annexed figure. There were two sleepers, one of which



was prepared with horizontal iron pins and an iron plate with pin holes at top. This was made the hind sleeper in laying the platform, and was a little longer than the other.

The fore transom and the two sleepers were made of fir scantling 6 inches square. All the other parts were of fir plank, 3 inches thick. This construction agreed with the only description of this kind of platform, that we had been able to procure at the time, excepting that we added a couple of ribbands to the side pieces, to prevent the wheels from running off, which did not form a part of that description.

Having first tried this platform on good solid ground, it appeared that the side pieces were much longer than was necessary for the recoil of the wheels, but the center piece was too short for the trail. We therefore cut the former to the reduced length of 12 feet, and moved the latter 8 feet further to the rear.

Having thus new modelled the platform, we tried it by firing 15 rounds with full charges of 8 lbs. of powder from the same iron 9½ feet 24 pounder on its travelling carriage, on the same alluvial soil, that had been the scene of our former experiments, with the mortars. The platform was in both cases laid with the usual slope of about 1 in 25.

The side pieces proved rather weak, as they bent under the weight of the gun, when the wheels stood half way between the sleepers, but the deflexion was too moderate to injure the timber. The side pieces reduced to 12 feet appeared a little too short, as the wheels very nearly ran off during the recoil, so that we were obliged to apply strong wedges, or full sand bags to check it. The lengthened trail piece was

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of the greatest advantage, as by preventing the trail from coming in contact with the ground at all, it allowed the gun to run itself up after the recoil, without any effort on the part of the gunners. Although the whole weight of the gun and carriage exclusive of the trail, which is comparatively insignificant, rested on the fore transom and two sleepers, no perceptible sinkage took place in the mud. Hence it is evident, that the recoil of heavy guns, fired at moderate elevations, produces no injurious effect upon a platform, unlike the recoil of a mortar, which after being fired, acts partly downwards on the principle of percussion.

In our practice with the above field traversing platform, we found that the iron plating and pin holes on the hind sleeper were useless, as the platform cannot possibly move laterally, when the weight of the gun is upon it. We also found the traversing pins, which had once been fitted to it, and which were continually breaking off, to be unnecessary; for in working upon firm soil, the handspikes had a sufficient purchase on the ground itself, and in soft soil, a piece of rough plank laid immediately under the ends of the side pieces, answered the purpose.

### 7. DESCRIPTION OF THE FIELD TRAVERSING PLATFORM FOR HEAVY GUNS, OF THE NEW PATTERN ADOPTED AT THIS ESTABLISHMENT, IN CONSEQUENCE OF THE ABOVE EXPERIMENTS. REMARKS ON THIS CONSTRUCTION.

*First.—Description of the construction of the Platform. (See the Figures afterwards given in this article).*

2 side pieces of fir each 12 feet 6 inches long, 12 inches wide, and 4 inches thick, bored with 3 vertical bolt holes 7-8ths of an inch in diameter, situated as follows. The center of the first hole 6 inches from the front, that of the second 3 feet from the rear, and that of the third 1 foot from the rear, each being bored in the middle of the wood. These side pieces have half inch iron bolts passing through them horizontally at the distance of 4 inches from each end, and clenched on the opposite side of the wood, upon iron collars, in the same manner as rivets upon their rooves. This is done to prevent the side pieces from splitting, as represented in the first figure in page 134, which is a gun platform plank supposed to be treated in the same manner.

1 trail piece, 12 feet long, composed of two baulks each 4 inches square, and placed at 16 inches apart from

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out to out, being connected in front by an intermediate piece 8 inches wide, 4 inches thick, and 3 feet long, and in rear by a similar piece of the same scantling but only 2 feet long. The front connecting piece or filling in piece has 2 vertical bolt holes, 7-8ths of an inch in diameter pierced through it, at a central interval of 2 feet apart, and each 6 inches from the ends of the piece. The sides of the filling in pieces and of the baulks are ploughed with grooves each about 5-8ths of an inch square, and tongued by pieces cut out of cross grained wood. Four horizontal half inch clenched bolts are used at the distance of 4 inches from the ends of each filling in piece, to rivet the parts of the trail piece firmly together.

The side pieces are connected by three transoms, which are as follows.

1 fore transom acting also as a sleeper, 7 feet long and 6 inches square. It has 2 iron screw bolts fixed to it, which will afterwards be described, placed at a central interval of 5 feet apart.

2 hind transoms, each 6 feet 4 inches long, 9 inches wide, and 3 inches thick, with the ends, which project a little, beyond the side pieces, rounded for the sake of appearance. Each of these transoms is pierced with 3 vertical bolt holes 7-8ths of an inch in diameter, at a central interval of 5 feet between the extreme holes, with the third hole exactly in the middle between these two, and is secured against splitting by a couple of half inch clenched bolts passing through it horizontally, at the distance of 4 inches from the ends.

*Iron work for the Platform.*

2 long screw bolts with heads 2 inches square and bodies 7-8ths of an inch square, driven through the fore transom with the heads let in flush with the under side of the wood, and with the projecting ends, which must be round, standing up not less than 5 inches above the top of the piece, the total length of each bolt being therefore at least 11 inches. They are for the purpose of bolting down the side pieces upon the fore transom, and they serve also as the pivots for the traversing of the platform.

6 short screw bolts of the same description precisely as the former, but 3 inches shorter, with the head and body square for the length of rather less than 4 inches, and the remainder round, the whole length being at least 7 inches. These are for the purpose of screwing up the two hind transoms to the side pieces, and of afterwards screwing down

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the trail piece upon the transoms. All these short bolts are entered from the top downwards, and their heads are let in flush into the side pieces or trail piece, to prevent them from interfering with the wheels or trail of the carriage.

8 nuts for the above bolts, each 2 inches square and 7-8ths of an inch thick.

16 iron plates for the bolt holes, 2½ inches square and 1-8th of an inch thick, with a hole 7-8ths of an inch in diameter, cut through the center of each.

The bolt hole at the front end of each side piece is plated both above and below, the remaining bolt holes of the side pieces on their lower sides only.

The bolt holes in the trail piece and the two transoms are also plated on their lower side only.

64 screws 1½ inch long for fixing the above plates.

4 half inch clenched bolts for the two side pieces,

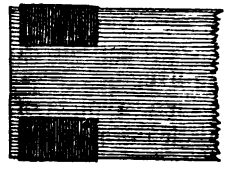
4 ditto for the 2 hind transoms, and

4 ditto for the trail piece, each sort being of unequal length, and fixed in the positions before stated.

4 iron clamps for plating the sides of the projecting ends of the side pieces, to prevent them from being worn by the handspikes in traversing. Each of these clamps is 1-8 of an inch thick, 6 inches wide, and 10 inches deep, but with 3 inches of the above depth turned over and 3 inches under the wood, at right angles to the central part,

8 vertical half inch rivets to fix the above.

To explain this arrangement more clearly, two figures are annexed, the first of which represents a section of the end of the side piece, taken through the iron clamps. The second is the plan of the same, showing the manner in which each clamp is doubled over the wood. The vertical rivets appear in both. One of the horizontal clenched bolts before described passes through each pair of clamps, as shown in the section.



The above wood and iron work constitute the whole framework of the traversing part of the platform, besides which are the following loose pieces.

3 sleepers each 9 feet long, 6 inches square and rounded on their upper surface, as shown in the annexed figure. The fore transom, which also acts as a sleeper, as was before stated, is rounded in the same manner.

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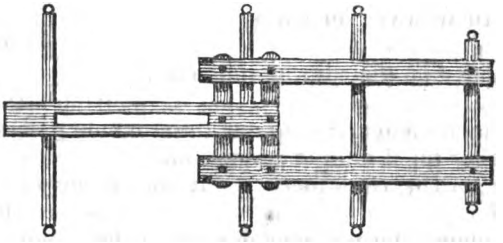
The following figures will explain the nature of the platform more clearly.

*Longitudinal Section of the Platform.*

*Plan of the Traversing Platform.*



*Transverse Section* 1.

*Transverse Section* 2.

Of the above transverse sections, the first is taken through one of the hind transoms, the two side pieces, and the trail piece; whilst the second is taken through the fore transom and the two side pieces.

In the plan, pickets represented by small circles are shown at the ends of the fore transom and of the three sleepers, the use of which pickets is to prevent the sleepers, which must not all be buried in the ground, from moving laterally.

Two wedges of hard wood are an useful or rather an indispensable appendage to this kind of platform, to form inclined planes for the wheels, in running the gun on or off the platform.

Each of these wedges is made out of a piece of elm plank 3 inches thick, 2½ feet long, and 1 foot wide, and as they must rise at least 10 inches at the thick end, this height is obtained by means of a

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block 12 inches long, 4 inches thick, and about 7 inches in extreme height. A tongue at the top of the block enters the under side of the wedge by a dove tailed joint. Four half inch clenched bolts are used to each wedge, 2 transverse ones to prevent the wedge from splitting, and 2 nearly vertical to connect the wedge and block together.

*Secondly.—Detail and Weight of the Parts of the above Platform.**

| *Woodwork.* | LBS. |
|---|---|
| 2 side pieces, 12½ feet long, 12 inches wide, and 4 inches thick, at 177 lbs..... | 354 |
| 1 trail piece, 12 feet long, 16 inches wide, and 4 inches thick..... | 143 |
| 1 fore transom, 7 feet long, 6 inches square..... | 75 |
| 2 hind transoms, 6 feet 3 inches long, 9 inches wide, and 3 inches thick, at 38 lbs..... | 76 |
| 3 sleepers, 9 feet long, 6 inches square, at 80 lbs. | 240 |
| 2 wedges at 31½ lbs..... | 63 |
| *Iron Work.* | |
| 2 long bolts 11½ inches long, and 7-8ths of an inch in diameter, with their nuts, at 3 lbs.... | 6 |
| 6 short ditto, with their nuts, at 1⅚ lb..... | 11 |
| Total 8 cwt. 2 qrs. 16 lbs., or ..... lbs. | 968 |

REMARKS. We made the side pieces 4 inches thick, which is perhaps nearly half an inch more, than is absolutely necessary for supporting well the weight of a 24 pounder gun, in order to allow something for the wear and tear occasioned by the friction of the wheels, in continual firing. When the trail of the carriage is confined and cannot alter its position, in reference to the trail piece, during the recoil or running up of the gun, we found that the wheels have no tendency to run off from the side pieces; and therefore we dispensed with the ribbands for confining them, which we used in our first pattern of the field traversing platform. In the act of traversing, which must always be done when the gun is run up, not before, handspikes are applied to the ends of the side pieces, not to the trail piece, as we found that the latter method racked and strained the parts. In pointing the gun, the best way is first to traverse the platform, until

* From actually weighing a new platform of this description, not from computation, in reference to the known specific gravity of the materials, as in some of our former details of a similar nature.

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the line is nearly obtained, and afterwards to move the trail a little, until it is quite correct. The trail of a 24 pounder travelling carriage has just 2 inches play, in moving on the trail piece. It may be remarked that a lighter platform than the above might answer for an 18 pounder, and a still lighter one for a 12 pounder gun. But taking all things into consideration, if the field traversing platform should ever be adopted for the service of a siege, I would prefer having only one pattern suited to the heaviest gun, in preference to several, which by getting intermixed after having been taken to pieces and packed for a voyage or a land journey, might cause great trouble and confusion. It may be remarked, that the trail piece should be a little narrower than 16 inches for the travelling carriages of guns lighter than the 24 pounder.

The parts of the field traversing platform should all be made of the very best materials, especially the side pieces, which should be entirely free from blemish. It is remarkable, how very little old seasoned fir planks, that have been much in wear, suffer from the wheels of heavy guns, whilst pieces of the same scantling coming new out of the hands of the carpenter are liable to injury. After much wear, no doubt the fibres of the wood become compressed, which must be the cause of the difference.

8. ESTIMATE OF MEN, TOOLS, AND IMPLEMENTS, NECESSARY FOR LAYING THE FIELD TRAVERSING GUN PLATFORM OF THE ABOVE PATTERN. THAT A SUNKEN BATTERY REQUIRES PART OF THE TRENCH TO BE CUT WIDER TO RECEIVE THIS PLATFORM. METHOD OF LAYING THE PLATFORM, AND TIME REQUIRED.

*First.—Estimate of Men, Tools and Implements.*

| | |
|---|---|
| 8 men | 1 six feet rod |
| 4 or 6 pickaxes | 1 screw wrench |
| 4 or 6 shovels | 8 strong pickets |
| 1 field level | 1 rammer |
| 1 maul | 1 line |

1 handspike for afterwards raising the sleepers when the platform is laid merely for practice.

*Secondly.—That a sunken Battery requires part of its Trench to be cut wider, to receive this Platform.*

As the traversing platform measures 21 feet, from the front of the side pieces to the end of the trail piece, and as the latter will require a space of more than 7 feet to traverse

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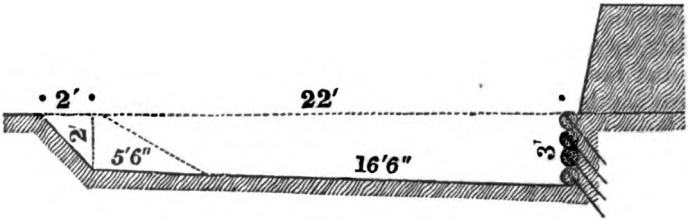
in, if it should be necessary to point the gun in different directions; it is evident that the trench of a common sunken gun battery which only measures 16½ feet at the sole, is too narrow for this kind of platform; and the width of the trench must accordingly be increased towards the rear, until the whole extent required for the movement of the trail piece shall become 22 feet wide, measuring from front to rear, making the depth in rear 2 feet, and giving the sole a regular slope from thence to the front, where the depth is 3 feet. This will only add 5 feet 6 inches to the width of the trench at bottom. When the vertical excavation necessary for producing this increase of width is completed, the sides and rear of the additional trench work may be finished by giving them a slope, whose base need not be greater than its height. In the common sunken gun battery on the contrary, where the rectangular platform is to be used, the slope was made much flatter, in order to allow the trail of the travelling carriage to ascend it with ease during the latter part of the recoil of the gun.




The foregoing figure is the section of a sunken gun battery, thus prepared for receiving a field traversing platform. The additional excavation is distinctly shown in rear of the reverse of the original trench, which is represented by an oblique dotted line.

*Thirdly.—Method of laying the Platform.*

Two men will cut a small trench or rather groove for the fore transom, which also acts as a sleeper, and which must be placed as close to the interior base of the parapet as possible, without impeding the traversing of the side pieces. The fore transom with the long bolts fixed to it and projecting upwards, must be sunk 6 inches or its whole depth below the surface. Two other men will sink a groove for the first sleeper parallel to the fore transom, at the central distance of 5 feet in rear of it. Two other men will prepare the groove for the second sleeper which must also

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be placed parallel to the former, at the central distance of 5 feet more to the rear. In a sunken battery the trench has a slope, but on level ground which might be the case in an elevated battery, the first sleeper should be sunk about 3¼ inches, but the second sleeper only about 1 inch below the surface. These pieces which are to bear the platform must be regulated accurately by the field level, with the usual rise of about 1 in 25 towards the rear, in which process the trail piece may be used as a straight edge, which is better than providing a more convenient one for the purpose, which would be an extra article.

Care must be taken to clear away the earth under the position of the two hind transoms, so as not to impede them in traversing, as their undersides are 3 inches lower than the tops of the sleepers.

In putting the platform together, the two side pieces, the trail piece, and two hind transoms, must first be connected, which is best done, at a little distance from the proposed position of the platform, and at right angles to it, for as was before observed the width of the trench of a sunken battery does not admit of laying out the platform otherwise. The short bolts are pushed or driven down through the side pieces and trail pieces with their heads entering flush into the wood, after which these pieces must be turned upside down so that the ends of the bolts shall project upwards. The two hind transoms are then laid close down upon the side pieces, and trail pieces, allowing the bolts to pass through both transoms, as far as they will go. The nuts are then screwed on above all by the screw-wrench, and the platform thus partly framed together is turned upside down, by the whole of the men moving it carefully so as not to strain the parts.

This being done, 3 men are stationed to each of the two side pieces, and 2 men to the trail piece, and the platform is then lifted up bodily by the whole of the 8 men, and carried to its proper position; and the fore ends of the side pieces are let close down upon the fore transom, by allowing the bolts which project above the latter to enter through the holes in the former, as far as they will go, after which the two remaining nuts are screwed on over all. The gun must now be got upon the platform by the rear, in which operation, the wedges before described or pieces of plank raised upon sand bags or upon small heaps of earth, must be used, to prevent the wheels from injuring the ends of the side pieces.

The third sleeper, which is to support the trail piece, must now be laid, parallel to the former sleepers, about 18



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inches in front of the extreme end of the trail piece, and in the same plane nearly with the others, which may require the ground under it, if originally level, to be raised a few inches. This sleeper from its length would be in the way of the wheels, in moving the gun upon the platform, if it were laid previously to that operation. But as it is best not to leave the trail piece unsupported, a sand bag, or block of wood, or the same sleeper laid obliquely so as to take up less room than the clear of the wheels, may be placed under it, until the gun is got into its place.

*Fourthly.—Time necessary.*—In an elevated battery, the traversing gun platform may be laid by expert men, who have practised this operation repeatedly, in about half an hour; and it can be completely dismantled in about 3 minutes. In this kind of battery fewer men than 8 would suffice for laying the platform, if it did not require to be put together and lifted bodily, as above described. In a sunken battery, which requires the trench to be widened in rear, each of the two diggers employed in this operation has a task of nearly 1½ cubic yard of excavation. In easy soil this may be executed by 2 men in about three quarters of an hour, and as the other men may be putting the platform together, whilst they are excavating, it will not cause much delay, especially as the reverse and side slopes of the additional trench may be cut after the platform is laid. But in difficult soil, the additional excavation required to prepare the sunken battery for receiving a field traversing platform, will occupy the 2 diggers nearly an hour and a half, and will delay the laying of the platform in proportion. Hence it may perhaps be better, whenever it is known before hand, that field traversing platforms are to be used, to make the additional trench work in the center of each one gun portion of the battery, a part of the task of the original reliefs of workmen, instead of throwing this part of the labour, upon the men afterwards employed to lay the platforms.

### 9. COMPARISON BETWEEN THE SIEGE GUN PLATFORM BEFORE DESCRIBED, AND THE FIELD TRAVERSING PLATFORM. THAT THE LATTER MAY BE ADOPTED IN PREFERENCE, WHEN PLATFORMS MUST BE CONVEYED BY LAND CARRIAGE, AND THE MEANS OF TRANSPORT ARE DIFFICULT.

The siege gun platform before described in Section VI, Articles 5 and 6 (pages 133 and 136) is the simplest kind of platform that can be used, and it can be made any where,

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provided that proper materials can be obtained, by common or even by inferior carpenters, and it is particularly easy of repair, if any part should be injured. The field traversing platform, on the contrary, would require to be made of the very best materials and workmanship, and under the most careful superintendence; and in the event of an equipment of such platforms being ordered for a siege, it would be necessary to have all the corresponding parts of each platform exactly alike; so that in case of the several platforms becoming mixed, which would be sure to happen after their being taken to pieces for embarkation or for land carriage, they might be put together again, in every possible variety of combination of their component parts, without embarrassment. The wood-work as well as the iron-work must therefore be all fitted by means of standing gauges.

Notwithstanding the absolute necessity for such extreme nicety of workmanship, yet when we consider the very serviceable nature of the above platform, which answers equally well in the firmest and softest soil, and that it does not weigh much more than one half of the simplest and smallest kind of rectangular fixed platform that can be used; it may be allowed, whenever it proves necessary to convey the platforms for a siege to any distance by land carriage, that the field traversing gun platform should be used in preference to any other, especially if the roads be bad and the means of transport difficult.

10. THAT THE SAME KINDS OF PLATFORMS ARE EQUALLY SUITABLE FOR GUNS OR FOR HOWITZERS.

This is a thing so generally understood, that I omitted to notice it, in former parts of this Essay, in treating of GUN PLATFORMS, which should have been included under the general and more proper title of GUN AND HOWITZER PLATFORMS. Not only the siege gun platform before described, but the field traversing platform also, are equally suitable for the service of the heavy iron 10 inch or 8 inch howitzer, and that of the 24 pounder gun.

11. THAT A SIMPLER AND LIGHTER KIND OF FIELD TRAVERSING PLATFORM, EVEN THAN THAT BEFORE DESCRIBED, MIGHT BE USED, BUT WHICH IS NOT RECOMMENDED IN PREFERENCE.

As the trail of the travelling gun carriage partly recoils upon the ground, in the common gun platform, which is not attended with any great inconvenience; if therefore we give up the trail piece of the former construction, as a thing not



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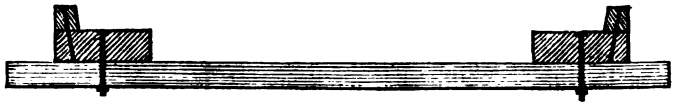
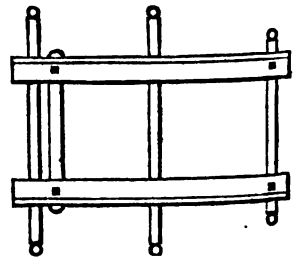
absolutely necessary, we shall obtain a simpler and lighter kind of field traversing platform, consisting of 2 side pieces 12 feet long, 12 inches wide, and 4 inches thick; with 1 fore transom serving also as a sleeper; 1 hind transom, bolted up to the side pieces, by means of bolts passing through bolt holes at the central distance of 2 feet from the ends of these pieces; and 2 sleepers.

The side pieces have ribbands of hard wood to confine the wheels, 3 inches high, 3 inches wide at bottom, and 2½ inches wide at top, being chamfered on the inside of each. 12 vertical half inch rivets at intervals of 2 feet apart are used to fix the ribbands to the side pieces.



The foregoing figure is a transverse section of the platform, on a larger scale than usual, for the sake of clearness. It is taken through the two side pieces, and shows the two ribbands rivetted down upon them, and the hind transom bolted up to them.

This arrangement, whilst it requires 2 ribbands in addition, dispenses with one transom, and one sleeper, as well as with the center trail piece of the former construction, described in Article 7 of this section. Of the parts retained it places the hind transom differently, and it dispenses with 6 inches of length in each side piece. In all other respects the construction is the same as the former. In laying the platform, the first sleeper must be laid at the clear distance of 4½ feet, and the second or hind sleeper at the clear distance of 10 feet, in rear of the fore transom. Thus the hind transom comes immediately in front of the hind sleeper. The annexed figure therefore represents this arrangement in plan, but on a much smaller scale, than the section.



This platform is certainly an efficient one, and would be lighter than the former by about 272 lbs. In fact its whole weight would only be about 6½ cwt. Notwithstanding this advantage I do not recommend it in soft alluvial soil, as the trail of the

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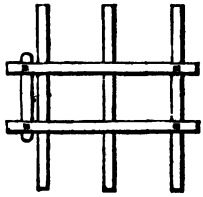
travelling gun carriage would sink into the mud; nor do I recommend it in any soil, in preference to the former traversing platform with the trail piece, which is certainly very complete.

The kind of platform described in this article, would answer still better, and in every kind of soil, for heavy guns mounted on garrison or ship carriages, but for this purpose, it would be necessary to diminish the central intervals between the side pieces from 5 feet to about 3 feet 5 inches.

### 12. THAT A FIELD TRAVERSING PLATFORM IS NOT SUITABLE FOR THE SERVICE OF MORTARS.

In consequence of the great satisfaction we derived from the field traversing gun platform, we fitted up a traversing mortar platform on the same principle, using 3 transverse sleepers, one of which also acted as a transom, each 6 inches square, and 7 feet 6 inches long, with 2 longitudinal pieces of the same dimensions, for the side pieces of the iron mortar bed to move upon. These were fixed to the front sleeper being also the transom by a couple of bolts, and were connected in rear by a hind transom of 3 inch plank. On firing two rounds from a 10 inch mortar at an angle of 45°, with 6 lbs. of powder, the shock of the second round broke the front transom or sleeper in two at one of the bolt holes, and also broke one of the side pieces, of which one part was driven nearly 2 feet to the rear in the recoil. This convinced us, that the traversing principle is not at all adapted to the service of mortars, for any increased dimensions capable of rendering a traversing mortar platform as strong as the common mortar platform, would in all probability cause the former to weigh more than the latter.



### 13. OF THE TREAD AND BEARINGS OF GUN AND HOWITZER CARRIAGES, WHEN PLACED ON THEIR PLATFORMS FOR FIRING.

The tread implies the transverse distance of the wheels or trucks when standing on level ground, by which the width between the side pieces of a field traversing platform, and between the parallel planks of a substitute platform, such as will be described in the next Article, must of course be regulated. The widest wheels are those of the 24 pounder carriage which measure 5 inches, at the tire. The

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narrowest are not less than 2½ inches.

The trucks of garrison carriages for 9 pounders measure 4 inches, for 12 pounders 4½ inches, for 18 pounders 5 inches, for 24 pounders 5½ inches, for 32 pounder guns, and for 10 inch and 8 inch howitzers, about 6½ inches in width.

The tread of travelling carriages, as well as of garrison or standing carriages, formerly varied more in different calibres, but recently, the tread of all travelling carriages of the new pattern is made exactly 5 feet from center to center: whilst the tread of all new garrison or standing carriages whether of wood or of iron is to be exactly 3 feet in the clear.

The term 'bearings' implies the distance between the points of support of the carriage in the longitudinal direction, or at right angles to the former. Hence in a travelling carriage, it is estimated between the point where one of the wheels touches the ground in front, to that where the trail touches it in rear. In a garrison or standing carriage, it agrees with the central distance between the fore and hind trucks. The following table states the bearings of both kinds of carriages.

| *Travelling Carriages.* | *Bearings.* ft. | in. |
|---|---|---|
| 24 pounder iron gun | 10 | 0 |
| 18 pounder iron gun | 8 | 11 |
| 12 pounder iron gun | 8 | 2½ |
| 10 inch iron howitzer | 6 | 1 |
| 8 inch iron howitzer | 5 | 5 |
| 12 pounder brass gun | 9 | 1 |
| 9 pounder brass gun | 7 | 10 |
| 6 pounder heavy brass gun | 8 | 4½ |
| 6 pounder light brass gun | 7 | 7½ |
| 24 pounder brass howitzer | 7 | 8 |
| 12 pounder brass howitzer | 7 | 0 |
| 5½ inch brass howitzer | 7 | 8 |
| *Garrison or Standing Carriages.* | | |
| 32 and 24 pounder iron gun | 4 | 4½ |
| 18 pounder iron gun | 4 | 1 |
| 12 pounder iron gun | 3 | 11½ |
| 10 inch iron howitzer | 4 | 8 |
| 8 inch iron howitzer | 3 | 8½ |

14. OF THE LOOSE PLANK PLATFORM, WHICH MAY BE USED AS A SUBSTITUTE FOR A GUN OR HOWITZER PLATFORM IN RICOCHET FIRING, WHEN TRAVERSING IS NOT SUPPOSED TO BE REQUIRED.

In consequence of having seen a couple of planks used

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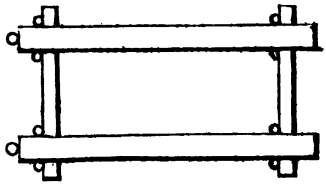
some years ago, in the ricochet practice of the Royal Artillery at Woolwich, I remarked in section VI, article 4, page 133, that regular platforms may be dispensed with in ricochet firing. For the purpose of ascertaining by actual experiment, the precise kind of substitute, that would answer the purpose, we laid a rude platform, consisting of a couple of 3 inch planks, each 12 feet long, and 10½ inches wide, upon two transverse sleepers. These planks were placed parallel to each other at a central interval of 5 feet, with the usual rise of 1 in 25, given to a common gun platform; and each of them was secured in its place by 5 pickets, 1 in rear, and 2 on each side near to the ends of the planks, as represented in the annexed figure.



On this temporary platform, a 24 pounder gun on a travelling carriage was placed, with the wheels resting on the planks but with the trail on the hind sleeper, which coincidence was accidental; and having fired a great number of rounds, with 2 lbs of powder, the greatest quantity likely to be used in ricochet firing, the recoil was generally only 13 inches. Afterwards we fired with 4 lbs. which produced an average recoil of about 2 feet 8 inches, and also repeatedly with full charges of 8 lbs. which produced a recoil never exceeding 7 feet 6 inches, but generally a little under 7 feet, which moderate length of recoil was occasioned by the friction of the trail on the ground, in rear of the hind sleeper. There was little or no tendency for the wheels to run off the planks, and the gun was run up again, after the firing, by four men with the greatest ease, and by two men without difficulty. Upon the whole the officers and men present were satisfied, that this kind of substitute forms an efficient platform even for a 24 pounder firing with full charges, provided that the gun be not required to traverse.*

Afterwards we used much shorter planks, which satisfied

* In the Note to page 133, I mentioned that platforms made with a few planks connected together, for the service of a 24 pounder battery, proved insufficient at Copenhagen, as the parts gave way, by which I meant that the planks separated. I am now convinced from our recent experiment at Chatham, which took place on the 7th of Feb. 1832, that the planks used as substitutes for regular platforms at Copenhagen would not have failed, if they had been secured by pickets in the manner described in this Article. I do not recollect the method in which we put them together, at the period alluded to.

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us that 4 pieces of 3 inch plank, each 6 feet long, two of them to be used as sleepers, will form an efficient platform for the ricochet firing, of a 24 pounder on a travelling carriage, the recoil of which is never likely to amount to 2 feet, excepting under very extraordinary circumstances. The pickets in rear of each plank are very useful, but the lateral pickets are less important, as the planks cannot move laterally, when the weight of the gun is upon them.

We were at first surprised, that the wheels should have no apparent tendency to move off the planks during the recoil. This however was accounted for, when we came to consider that the powder acting in the direction of the axis of the bore, gives a much more accurate impulse to guide the wheels in their backward movement, than could possibly be communicated by men with handspikes.

For guns mounted on garrison or standing carriages, the sleepers or transverse planks need not be more than 5 feet long, but the longitudinal planks must not be less than about 9 feet long, as the hind trucks must not be allowed to recoil entirely off from those planks.

### 15. OF THE CHESS PLATFORM, THAT MAY BE USED AS A SUBSTITUTE FOR A GUN PLATFORM, EVEN IN FIRING WITH FULL CHARGES, AND WHEN TRAVERSING IS FREQUENTLY REQUIRED.

This construction suggested itself in consequence of the experiments recorded in the preceding article; and it only differs from the expedient, therein described, in having a chess instead of a single plank for each wheel to run upon.

A chess implies two or three planks ledged together, the object of which is to obtain greater width, in order to admit of traversing the gun. The least width that can be of use for this purpose is 2 feet: the greatest width need not exceed 3 feet.

Chesses 2 feet wide may be composed of 2 planks, but those of $2\frac{1}{2}$ or 3 feet in width should be composed of 3 planks, each 12 feet long, and $2\frac{1}{2}$ or 3 inches thick, the former of which thicknesses will be quite strong enough, when the platform is laid on solid earth. In softer soil the latter dimension may be preferable. Each chess is ledged at the ends, by a piece $5\frac{1}{2}$ inches wide, made out of 2 inch plank, and fixed transversely to the longitudinal planks of which the chess is composed, by 5 clenched nails per plank.*

* The best kind of nails are those called knee nails by shipwrights, which being oblong in section are not so liable to split the wood as common nails.

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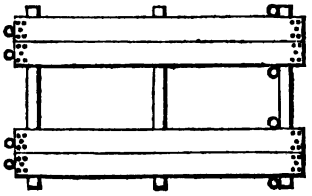
Thus a chess of 2 planks will have 20 rivets, but one of 3 planks will have 30, at its two ends. The adjacent planks of each chess have their joints plowed and tongued, the grooves in the planks being half an inch square, and the tongues one inch by half an inch, in section.

The chesses which are laid parallel to each other at central intervals of 5 feet apart, with the ledges downwards, are supported by 3 sleepers, which may be 5 inches square and from $7\frac{1}{2}$ to $8\frac{1}{2}$ feet long, the former length being proper for 2 feet chesses, whilst the latter is proper for 3 feet chesses. The annexed figure represents a platform of this description formed with 2 feet chesses, and resting on 3 sleepers. The extreme sleepers must be laid just within the position of the ledges, with the other sleeper equidistant between those two. Four pickets are shown in the plan, driven just behind the chesses, which should be stronger than usual. Four lateral pickets only are also shown, which are of less importance, for the reason stated in the preceding article.

*Plan of the Platform.*



*Longitudinal Elevation.*

If it were required to make such platforms in the field in a hasty manner, it would be better to use four ledges to each chess, instead of plowing and tonguing the planks; and in this case the extreme ledges should be placed about an inch and a half from the ends of the chesses, to prevent the planks from splitting, in case of the nails being carelessly driven.

The chess platform such as has been described, is by no means well adapted for soft alluvial soil, for there it would require an extra sleeper, besides a trail piece of some kind, such as a plank or a baulk, to prevent the trail of the gun carriage from sinking in the mud during the recoil, which it would probably do, if left unsupported for any length of time, in firing. The chief objection to this arrangement is, that such a trail piece would require to be shifted as often as the gun was traversed, which would give a great deal of trouble to the gunners, unlike that of the field traversing platform, which causes none.

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In firm sound soil on the contrary it is no doubt a very efficient platform, simple in its construction, and easily laid or moved. And it would also be light, for I calculate that a platform of this description having 3 sleepers, and a couple of chesses each 3 feet broad, which would be very convenient for traversing, would scarcely weigh 5½ cwt.

### 16. OF ARMING THE WORKING PARTIES EMPLOYED IN THE CONSTRUCTION OF BATTERIES.

In the seventh section of the first part of this work (page 53), the question as to the expediency of arming the working parties in a siege was fully discussed, and it was remarked, as being less objectionable to arm the working parties employed in the construction of batteries, than those employed about the first parallel and the approaches connected with it.

In referring back to the above, my only object now is to recommend a different mode of fixing the bayonet, when the firelock is slung behind the back, with the sling in front passing over the right shoulder and under the left arm, in order to enable the soldier to carry tools and materials also. In this case the bayonet must be fixed in reverse or pointing downwards, in the manner shown in the annexed figure, in preference to the upright mode of fixing it, which we found inconvenient, in the event of a man stooping to put down his gabions, and suddenly rising again, which may be rather dangerous to a person immediately behind him.

After the armed working parties about to be employed in the construction of a battery shall have arrived at the spot, they may be directed to disengage their bayonets, and fix them properly, before they pile or ground their arms, previously to their commencing the work.

### 17. WHETHER BREACHES MAY NOT OCCASIONALLY BE EFFECTED BY MINING, IN PREFERENCE TO BATTERING GUNS.

In the general view of the equipment and arrangements of the Artillery for a Siege, contained in the twelfth section of this work, one article, the 10th, (page 222), was devoted to

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the consideration of the weight of guns and ammunition, and of platforms and magazine timbers, necessary for effecting a practicable breach of 60 feet. in a revetment of good masonry, together with the means necessary for transporting them. The magnitude of this equipment, when considered in detail, will probably suggest to the mind of the reader, whether it may not occasionally be advisable to have recourse to mining for this purpose, in preference to battering guns, or in cooperation with them. But the consideration of this important question will be reserved for the third part of this work, in which it is proposed to treat of the final Operations of a Siege.

END OF PART II.

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*N. B. The Wood Engravings were executed by Corporal Thomas Fraser and Private William Turner, with occasional assistance from other Men of the Corps. The emblem in the Title Page was engraved by Major Charles Cornwallis Michell.*

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